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(*See page* 14)

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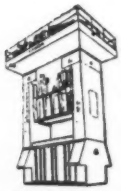
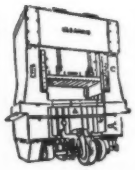
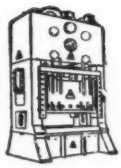

Straight Side Hydraulic


Bottom Drive Mechanical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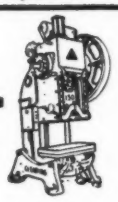
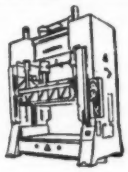
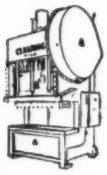
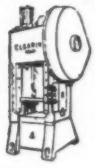
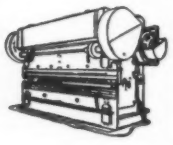
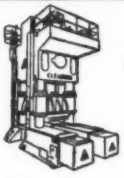

O.B.I.

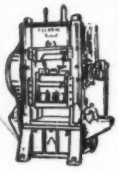

Die Spotting

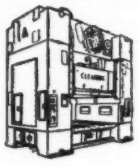

Gap Frame


One-Point Press

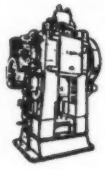

Heavy Duty Brake Press

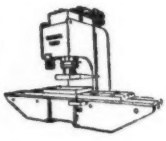

Four Column Single Action


Knuckle Joint


Enclosed Series S

Horn


Forging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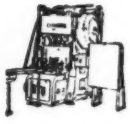
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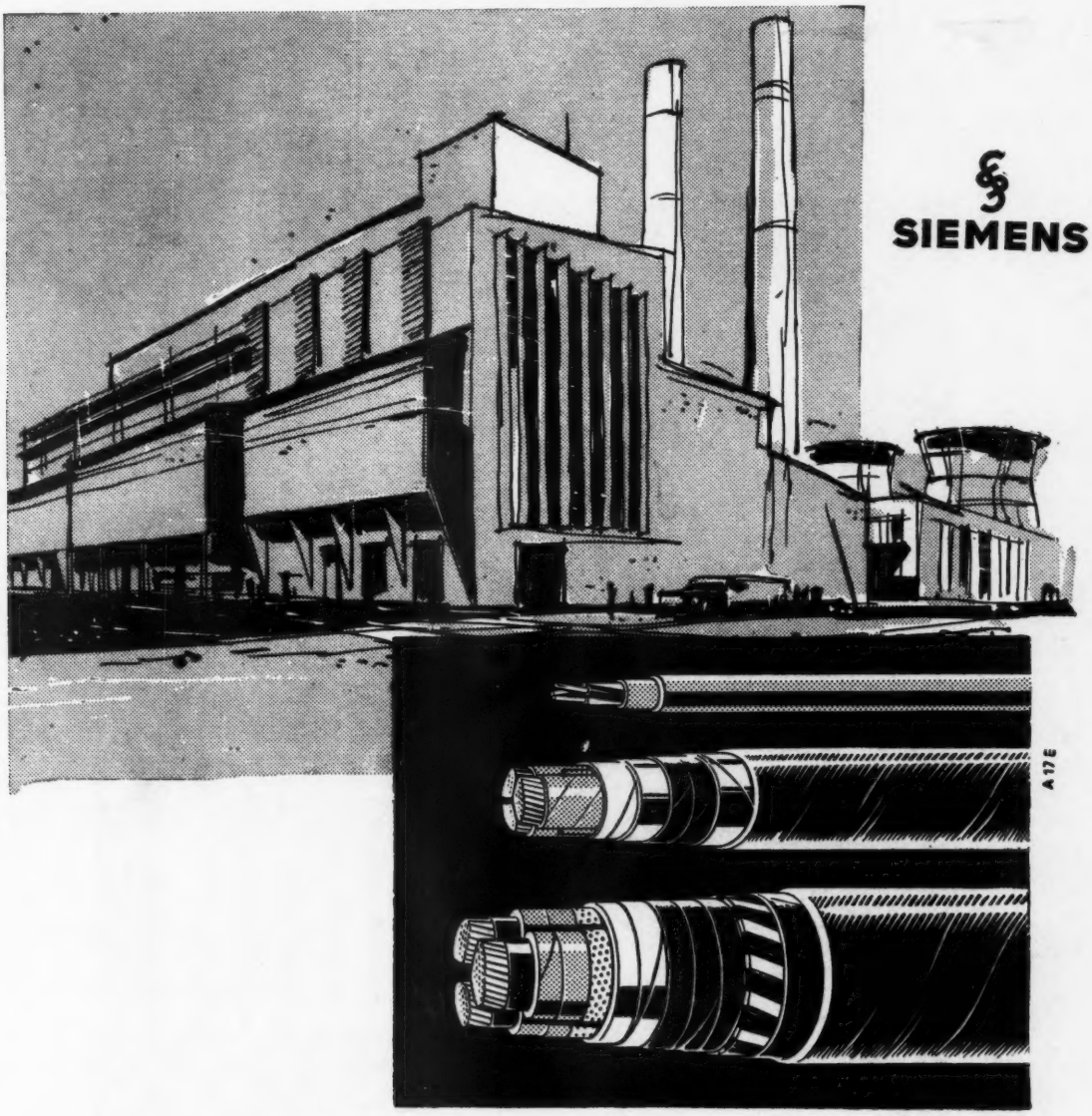

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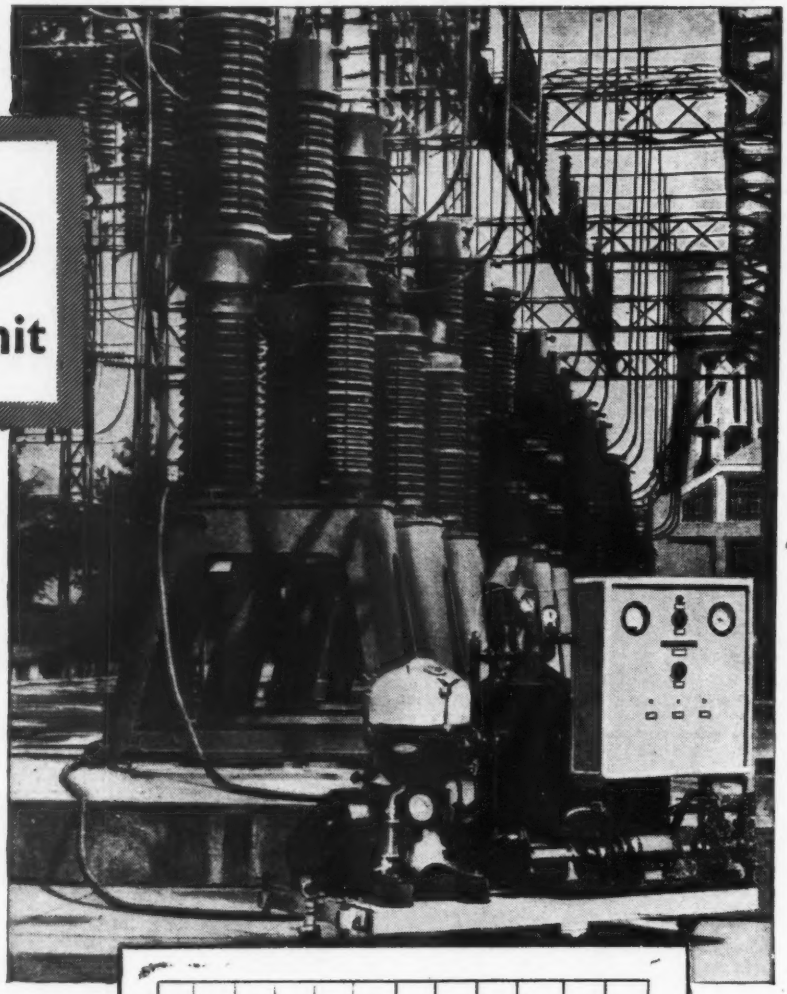

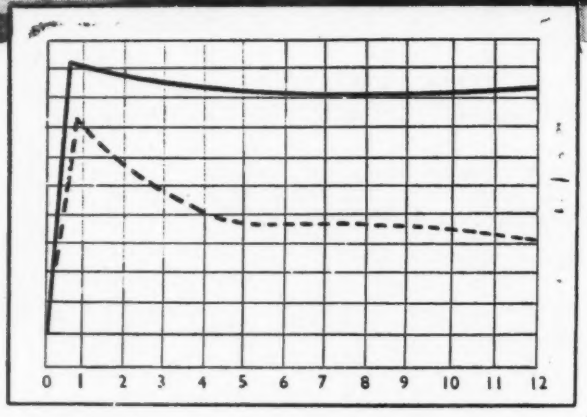

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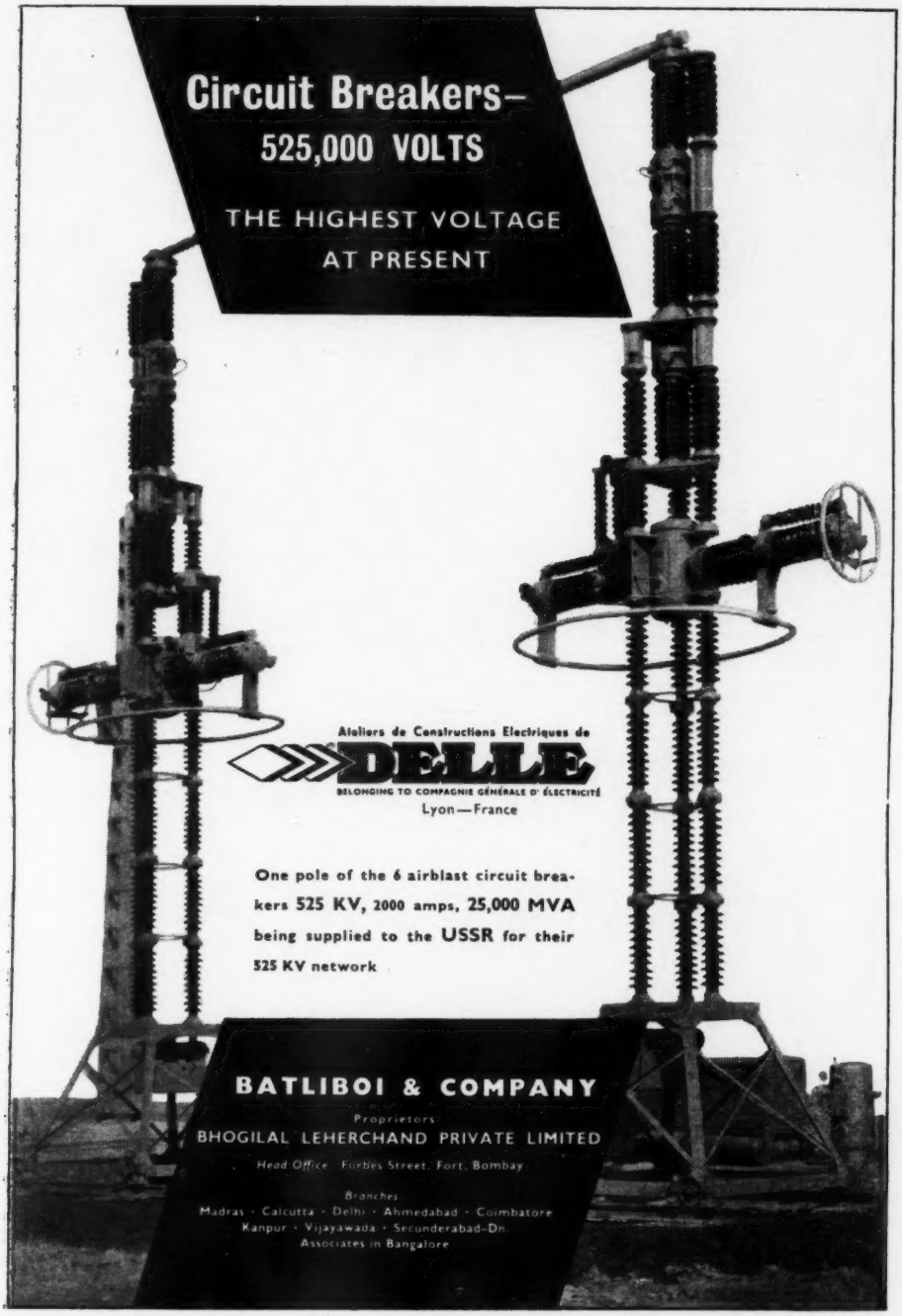
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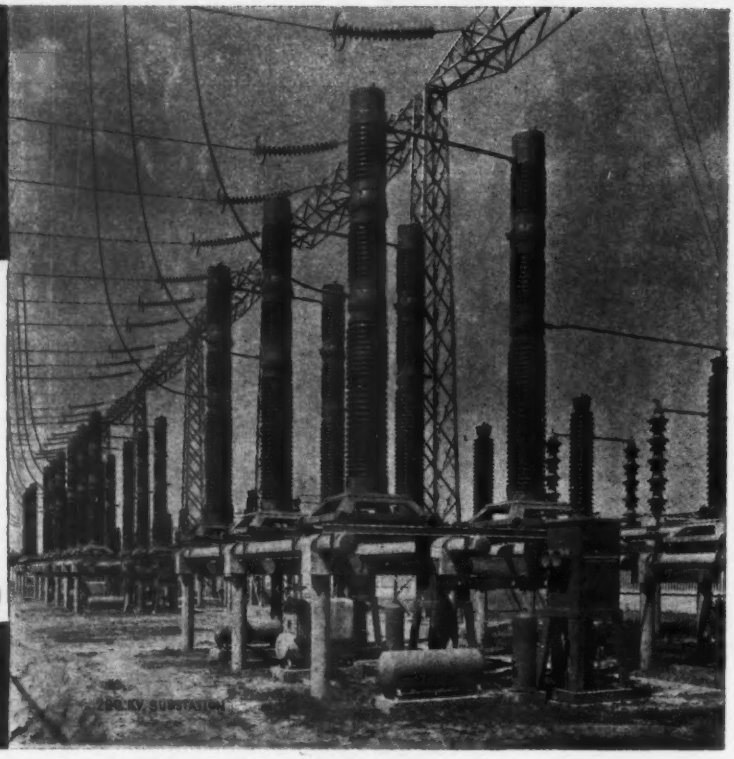

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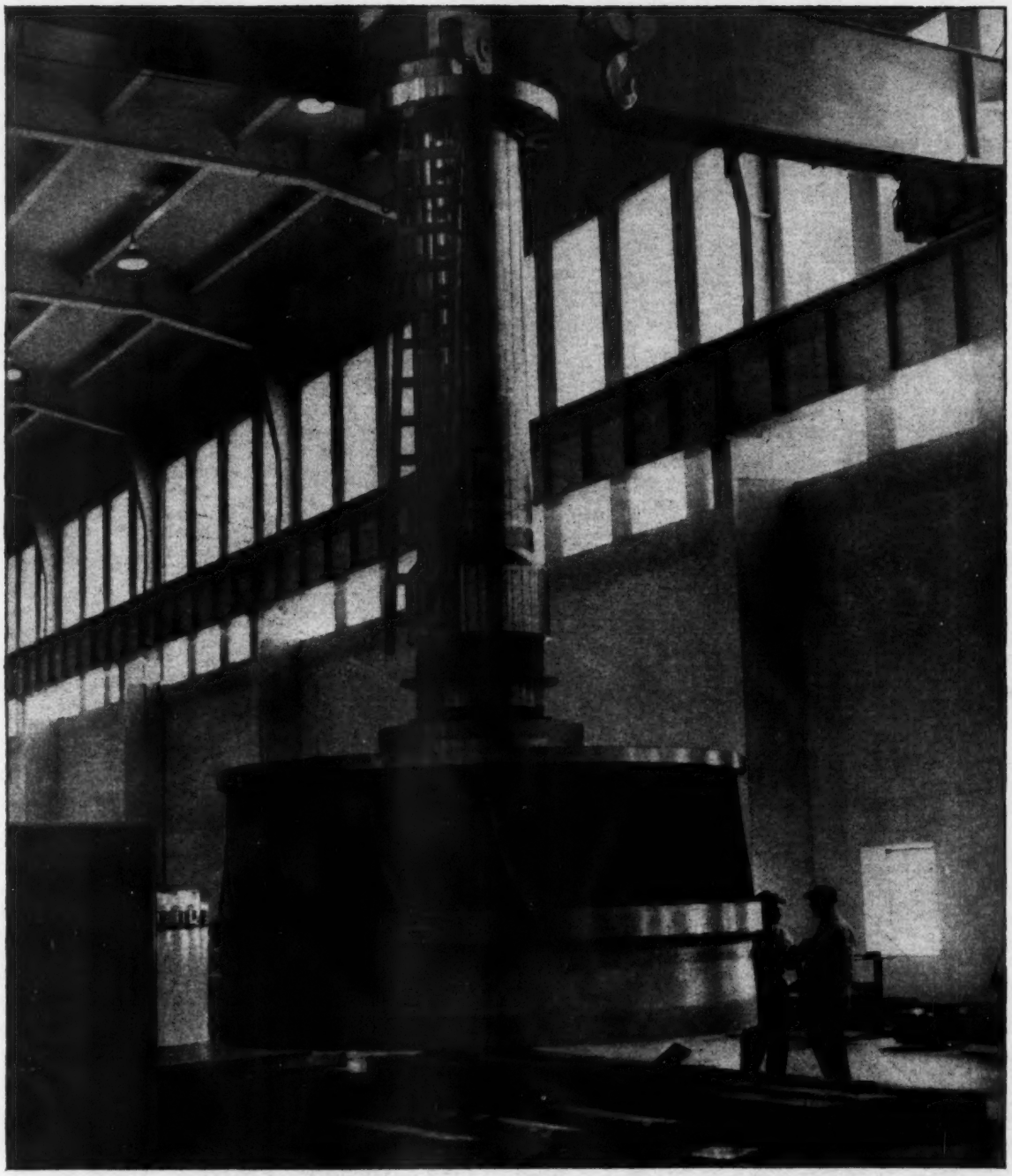

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Fearless with our two hands today
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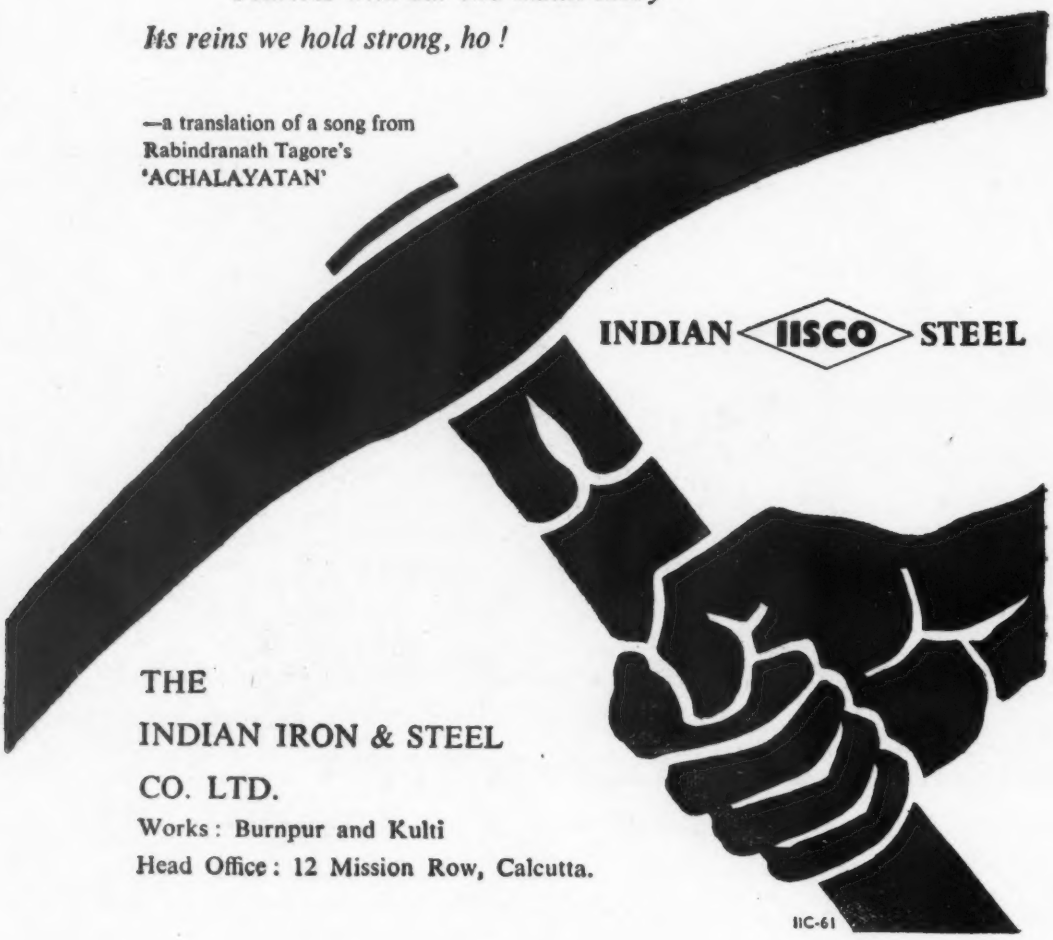

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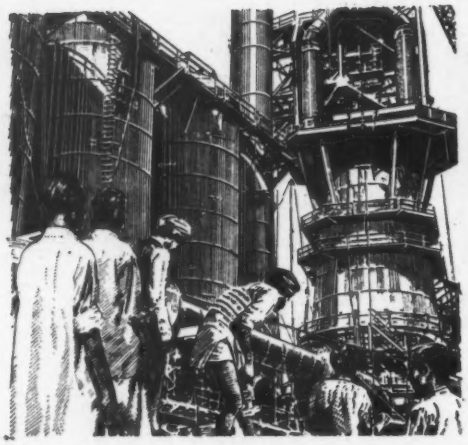

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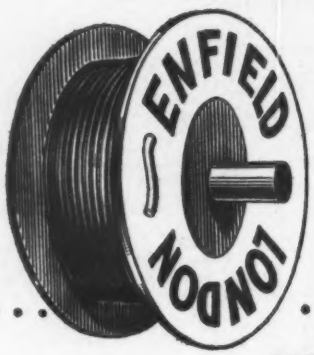

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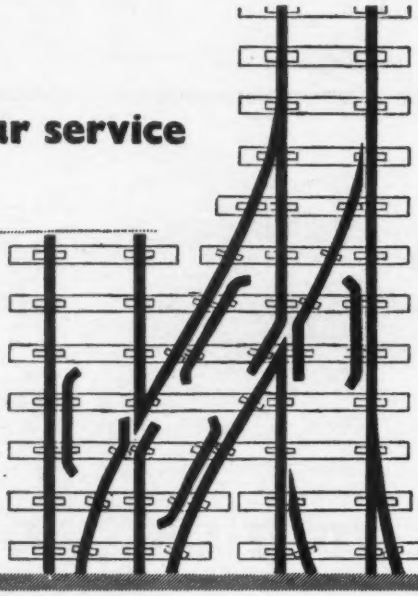

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Editor : K. K. Sinha — P. K. Menon : Mg. Editor

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Economics of Pumped Storage

Dr. CHARLES JAEGER

In recent years, renewed attention has been given to pumped storage and the economics of combined methods of power production together with pumping.

The analysis of this problem of economics can be dealt with from two different angles.

A. From the angle of general power requirements and demand: This leads to a mathematical analysis of power systems which is the subject of a paper submitted to the Engineering Institute of Canada.

B. From the angle of actual power production. The best approach would be a systematic study of existing designs of pumped storage.

A. Economics of Pumped Storage from the Angle of Power Demand

This investigation on the economics of pumped storage started considering an electric system similar to the British system, which is rather compact, and where addition of nuclear power is an urgent problem. The Canadian system, extending over immense areas, with still considerable hydro power potential in reserve and the possibility of additional seasonal and yearly storage of water, offers conditions which are at the opposite of what the British system is to-day.

Can a method devised to analyse conditions in the former system be adapted to conditions in the latter?

The answer must lie in the method itself.

Planning of new sources of electric energy is based on extrapolating the load demand curves many years ahead.

Any suitable method of investigation must tend to reduce the number of free parameters to a minimum. The method submitted here is entirely based on the analysis of the load factors of the system and its components.

It can also be shown that the balance sheet of power and energy production by a group of stations depends entirely on these load factors too, as do the prices and costs.

The system load factor is a quantity which varies slowly with time and its trend can be predicted several years ahead. A method of price analysis entirely based on these load factors makes economic predictions fairly reliable and the method can be adapted to a wide range of alternative cases.

Let us lock into the details of this method of analysis.

Any electric power system with a total installed capacity M and a system load factor Θ_s can be broken down into system components characterized by their installed capacity N_1, $N_2 \ldots N_i \ldots$ and their load factors Θ_1, $\Theta_2 \ldots \Theta_i$ taken over aperiod T. (Fig.1)

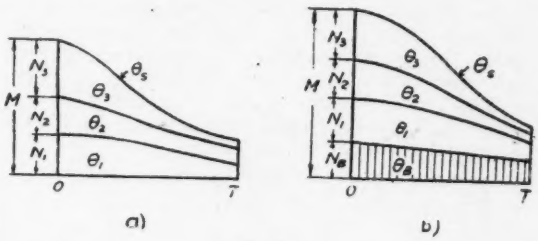


Fig. 1.

The following general theorems can be demonstrated*

1. There is a linear relation between Θ_s and $\Theta_1, \Theta_2 \ldots \Theta_i$ depending only on $N_1, /M \ldots N_2 /M \ldots N_i /M$. This linear relation does not depend on the shape of the duration curve derived from the load/time curves of the system as given (Fig. 2) below:

Basic equations

$$\Theta_s M = \Theta_1 N_1 + \Theta_2 N_2 + \ldots + \Theta i Ni + \ldots$$

$$\Theta_s (M + N_m) = \Theta_1 N_1 + \Theta_2 N_2 + \ldots + \Theta_1 N_1 + \ldots + \Theta_m N_m$$

Condition of on change in existing system Θs M is:

$$\Theta_m = \Theta$$

Condition for change of load factor Θi to Θi
$= \Theta i + \triangle \Theta i$

$$\Theta_m = \Theta_n - \frac{N_i}{N_m} \triangle \Theta_i$$

2. Any new source of power with capacity N_m and load factor Θ_m added to an existing system ($M\Theta_s$) may change the load conditions in the system components ($N_i \Theta_i$). The condition for no change to occur in the existing system is $\Theta_m = \Theta_s$.

*These theorems are demonstrated at full length in the original manuscript submitted to the E. I. C. and published in June, July, August 1958 by "Water Power", London.

In the more general case

$$\Theta_m = \Theta_s - \frac{N_i}{N_m} \triangle \Theta_i$$

where $\triangle \Theta_i$ is the change occurring in the system $(N_i \Theta_i)$ owing to the addition of a new source of energy $(N_m \Theta_m)$. This fundamental relation will allow us to relate the price analysis of the new system to price changes occurring in the component "i".

3. More detailed investigations, especially investigations concerning pumped storage, required the exact knowledge of the true duration curve of the system. For the sake of theoretical system analysis, the true duration curve can be replaced by a convenient mathematical curve which can be integrated.

The choice was for the so-called Soschinski function, which is found to match actual duration curves in a great number of cases, particularly those for large systems. This function shows the load N at the time t $(0 < t < T)$ to depend only on Θ and $\Theta_o = m/M$ where M is the maximum (installed) capacity; m the minimum required load. (Fig. 3)

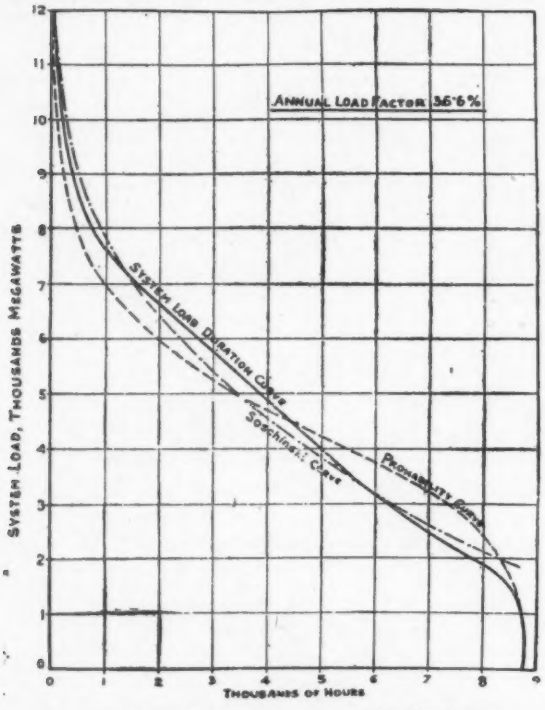


Fig. 3. 1957 load duration curve for England areas.

The Soschinski functions is

$$N = M\left[-(1-\Theta_o)t^{(\Theta-\Theta_o)/(1-\Theta)}\right]$$

Both Θ and Θ_o can be predicted from a number of real load duration curves.

The basic problem for which the Soschinski curve will be used is to find out the best possible utilization of a given pumped storage or the theoretically best design and suitable capacity for a pumped storage to match a given base load station. If A_2 is the energy required by the pumps and A_1 the energy generated by the generating sets in the pumping scheme, then $A_1 = \eta A_2$ where η is the overall efficiency of the pumping scheme including transmission losses. (Fig. 4).

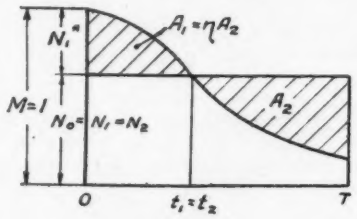


Fig. 4.

The basic problem corresponds to an ideal case of full utilization of the base load ($\Theta_B = 1$). For practical purposes the following additional research will be required:

Comparative estimates will be carried out for a base load characterized by $\Theta_B = 1$ and by $\Theta_B < 1$. (Fig. 5).

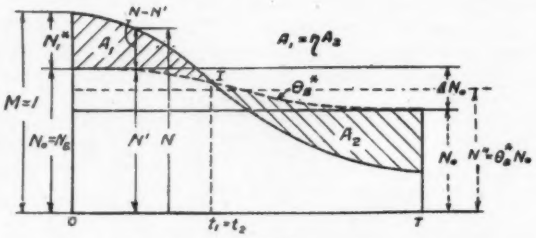


Fig. 5

When there is a time lag $\triangle t$ between the stopping of the pumping and the beginning of generation, there is a loss of power $\triangle N$ and energy $\triangle E$ given by

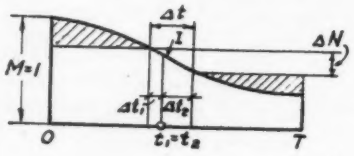


Fig. 6

$$\triangle N = \left(\frac{dN}{dt}\right)_{t_0} \triangle t, \quad \triangle E = T.\triangle N$$

(Fig. 6, 7.)

The overall efficiency of a system combining pumping and generating depends widely on the transmission distance between the primary base load station and the pumping station. When two alternatives corres-

Basic equations

Soschinski Curve

$$N=M\left[1-(1-\theta_0)t^{\frac{\theta-\theta_0}{1-\theta}}\right]$$

Energy equation for pumping:

$$A_1=\eta A_2$$

Effect of time gap Δt: $\Delta N=\left(\frac{dN}{dt}\right)_0\Delta t$; $\Delta E=\Delta N.T$

Variation of efficiency: $\Delta N_2=\Delta N_1+\frac{\eta_1-\eta_2}{T}A_2$; $\Delta\Delta A=(\Delta N_2-\Delta N_1)T$

Price equation

$$k=nN+mE$$

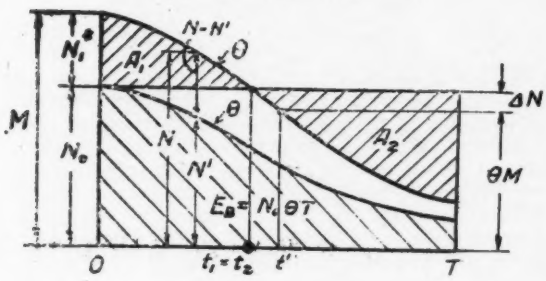
Fig. 7

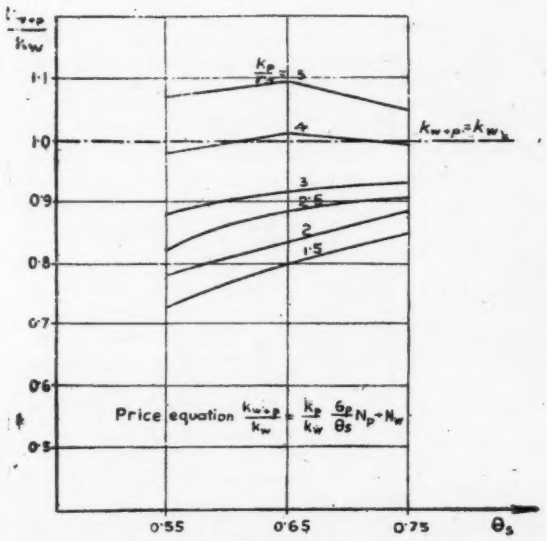
ponding to efficiency factors η_1 and η_2 have to be compared, the loss of power for both alternatives is given by

$$\Delta N_2=\Delta N_1+\frac{\eta_1-\eta_2}{T}A_2$$

4. A detailed balance sheet has to be estabilshed for all energies generated, transformed and lost. (Fig. 8)

Fig. 8. (top) Fig. 9. (bottom)





It can be shown that such a balance sheet can be traced graphically and that the only variables to be considered are θ (the load factor of the demand curve), θ_B (the load factor of the base load station) and the overall efficiency η for pumping.

Most of the problems of cost and prices can be represented by fairly simple mathematical functions. So can the problem of the price of electrical energy, which is of the form

$$k=nN+mE$$

where $N=$ installed capacity; E generated energy n and m constant factors which can be shown to depend mainly on θ.

Summarizing this, it can be shown how the whole problem of costs and prices—analysed from the point of view of the demand for more power—depends mainly on the load factor analysis, the main free parameters being θ_s the system load factor and θ_B the base load factor.

Figure 9, referring to hydro power combined with pumped storage, is most instructive k_w is the price of 1 kWh. produced in a hydro power plant working alone (capacity N_w); k_p is the price of 1kWh. of energy generated in the pumping plant with capacity N_p and k_{w+p} is the cost of the unit energy generated in a combined system of water power supplemented with pumped storage. The system load factor θ_s is the main variable and the ratio k_p/k_w the main free parameter. The condition $k_{w+p}\leq k_w$ for the combined system to be economical is obtained for a wide range of value k_p/k_w as shown aon this Fig. 9. It is possible with such a diagram to estimate a limit for which the ratio of costs per kW or prices per kWh is in favour of hydro alone or of combined hydro power and pumped storage.

An equivalent diagram is easy to trace for combined nuclear power and pumped storage. Both diagrams show that it is economical to add large pumping stations to a system basically fed by run-of river stations or by nuclear power. Substantial savings are possible, up to 20 per cent on the price of the kWh generated.*

The combination of steam power and pumped storage leads to more intricate calculations, because the cost of coal must be included as a main variable of the problem. The diagram Fig. 10, above of the Energie Versorgung Ost Bayern in Bavaria shows such a combination to be economical. But data from other countries (U. S. A.) show that this combination is often a a marginal case. For practical purposes a combinaion of run-of-river power, thermal energy, and pumped storage will often have to be considered.

B. Research for Suitable Practical Solutions (from the Production Angle)

The second point to be discussed concerns practical

*Full details are given in the August 1958 issue of "Water Power."

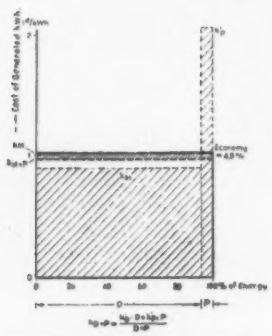


Fig. 10. Compared cost of power generation for steam and for steam plus pumped energy.

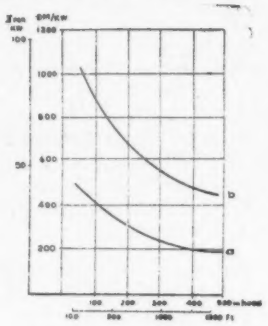
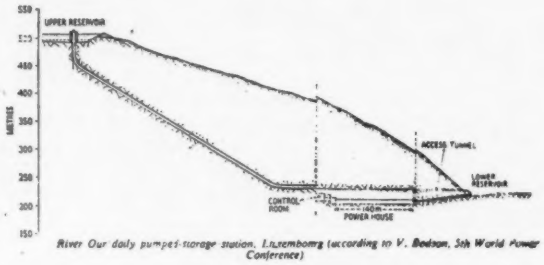


Fig. 11. Cost of German pumped storage stations in DM. or £ per kw. for head from 100 to 1500 ft. (a) costs in 1926-1930 ; (b) costs in 1956 average.

pumped storage designs which can be commended as being economical proposals. The best approach is to review typical schemes and to comment on them from the angle of their economical advantages.

Pure and Mixed Pumped Storage

Pumped storage is said to be pure pumped storage when the total discharge and the head are the same for the pumps and the turbines, or mixed pumped storage when there is more water passing through the turbines than through the pumps and/or when the head available for power generation is greater than the head against which the pumps have to work. Typical example of the first arrangement are *Ffestiniog* (300,000 kW.) (Fig. 12) in Wales or *Our* (320,000 kW.) in Luxemburg (Fig. 13).



River Our daily pumped-storage station, Luxembourg (according to V. Bodson, 5th World Power Conference)

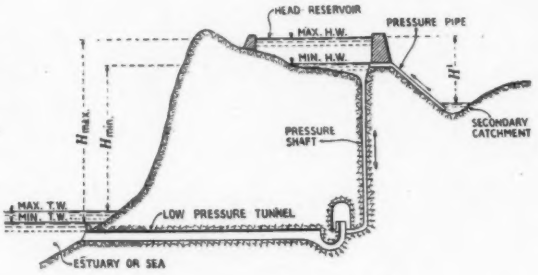
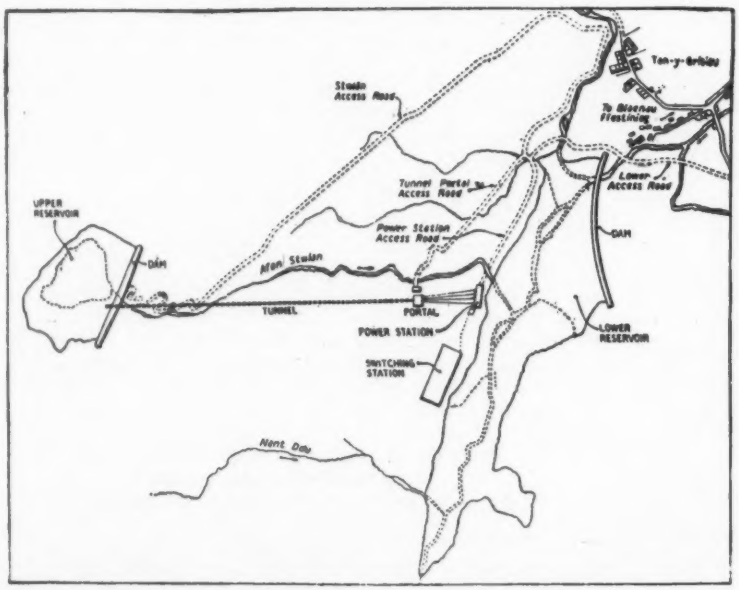


Fig. 13. (top) Fig. 14.

The first station uses conventional pressure tunnel, surge tank and pipe lines, the second, built in the centre of the West-European coal industry, is underground with an inclined shaft. It has also been suggested to use cliffs near the sea for installing pumping stations of this type (Fig. 14). The Sir Adam Beck Niagara pumping station in Ontario (20,700 kW.) is a well-known example of conditions where the total head available for power generation is larger than the pumping head. (Fig. 15 and 16).

Fig. 12. Sketch map of the Ffestiniog scheme in North Wales (according to V. G. Newman, BEAMA Journal).



Reisach in Bavaria is a more complicated design : there are two low level reservoirs with two stations equipped with pumps and turbines but only one common high level storage reservoir. By skilfully combining these three reservoirs it is possible either to produce a maximum of kWh. or to have the highest possible capacity in kW. (Fig. 17).

Effect of Head on Price of Pumped Storage.

Another remark concerns the total head of a pumping station. Comparative price studies based on German pumping stations show the price per installed kW. to decrease with the pumping head. This is easy to visualize. (Fig. 11).

Availability of Excess Energy

An even more striking difference

Fig. 15. An aerial view of the Sir Adam Beck-Niagara generating stations (E, F) with the reservoir for pumped storage (L).

exists between daily storage, weekly storage and yearly storage, with rapidly increasing unit prices when passing from one type to the next. This last problem is linked with the availability of excess power. In the past the market analysis for excess power has received possibly too little attention. From the point of view of pumped

Fig. 16. Section through the Niagara pumped-storage station showing the extremely compact layout obtained with a reversible Dériaz pump-turbine.

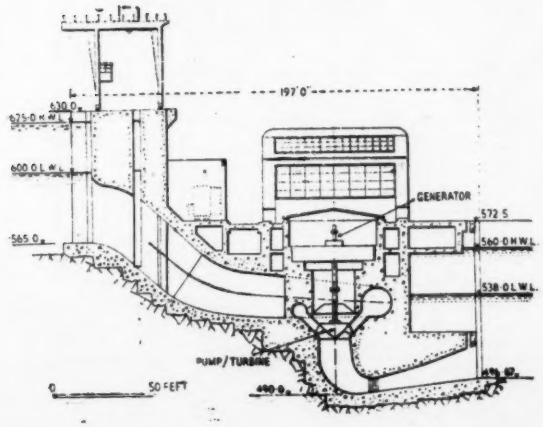
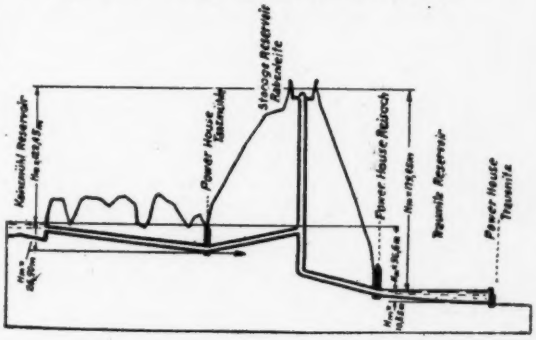


Fig. 17. Reisach pumping scheme (Bavaria).



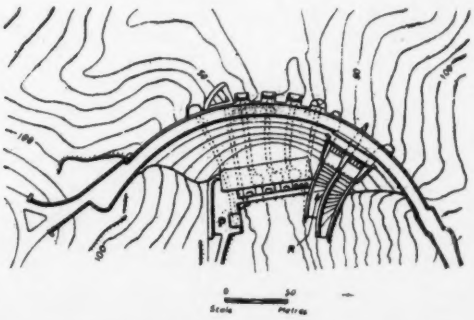


Fig. 19. Diagram of English Electric Co. arrangement to improve an existing low-head scheme.

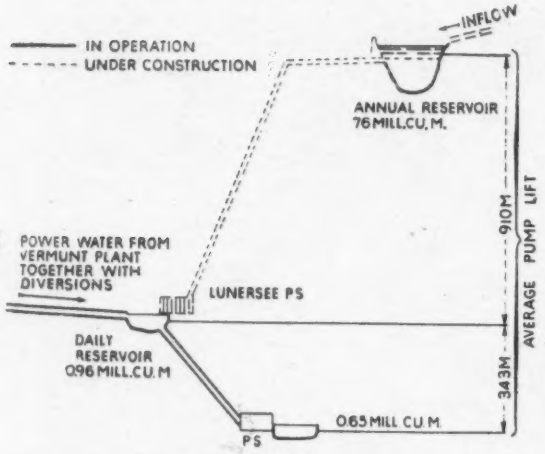


Fig. 18. The Rodund and the Lünersee pumped-storage schemes of the Vorarlberger Illwerke (according to A. Ammann, 5th World Power Conference).

storage economics it is of great importance. Cheap generation of pumped energy is possible only if excess power is available in convenient quantities for convenient periods of time. In favourable cases, daily or weekly storage may be possible. If not, yearly storage may have to be considered which is a quite different proposal.

(*a*) *Cheap night power always available.* Let us suppose a base load nuclear station running at a very high load factor Θ_B. Excess power will be available every night, all over the year, and combination with a daily or weekly storage is attractive. It can be shown to be economical and the economy on the generation of 1kWh. can be as much as 20 per cent. or more.

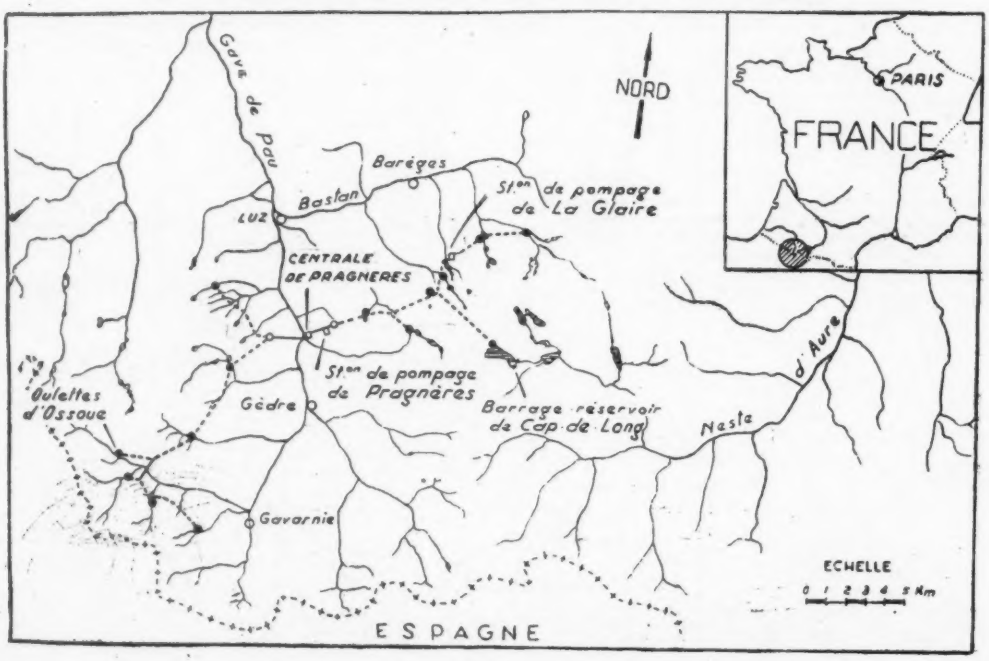
It is estimated that is Canada nuclear energy compared with conventional steam energy may become economical about the year 1980. If pumped storage is considered in combination with the production of base load, then the point of equal production costs may come several years earlier.

Another most interesting solution concerns the case of a large run-of-river station capable of producing constant yearly power. The station may be assumed to be located at a great distance from the centre of load consumption. Only base load is to be transmitted over such a distance. A pumped storage scheme located near this centre produces the corresponding daily peak load and considerably improves the conditions for overall cheap power production. Such conditions are likely to occur in Canada, where vast resources of potential energy are available in the far north of the country.

In both cases mentioned, the basic fact is that cheap constant base load power is available over long periods when the pumps can work to make daily generation possible at a convenient load factor.

(*b*) *Excess night power available only over limited periods.* The opposite example concerns run-of-river plants where excess power is abundant during the rainy period but scarce during the dry season. Such conditions are characteristic of the European Alps: power is scarce when most required and yearly storage

Fig. 20. General plan of the Pragneres development in the French Pyrenees.



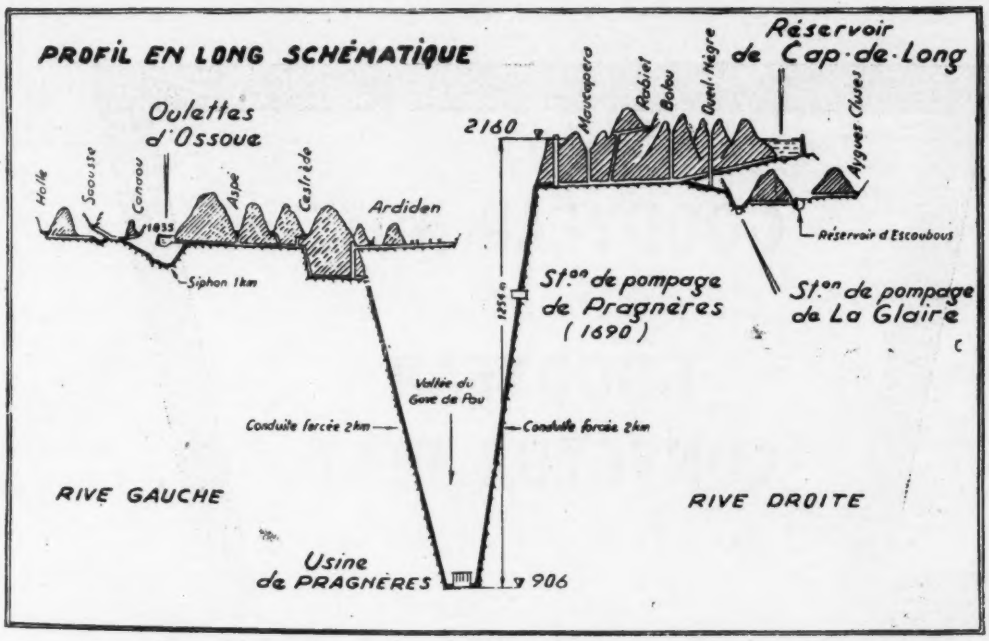


Fig. 21. Schematic profile of the Pragnères development.

has to be considered. *Waggital* and *Etzel* in Switzerland are wellknown examples of yearly storage, where additional pumping of water during the wet season is used to fill existing conventional water power reservoirs for generation during the dry season. The two schemes are mixed pumping schemes, and the large reservoirs were first built for conventional production of hydro-power only.

An alternative solution to this arrangement is shown by the *Illwerke* in Austria, where a daily storage (170,000kW) and a yearly storage reservoir (217,000 kW), with its own catchment area, are used simultaneously. The Illwerke are designed to be the main regulator for power generation and frequency regulation on the central European system. (Fig. 18).

Extension of Existing Conventional Hydro Power Schemes

Reverting to mixed storage schemes, the introduction of pumped storage to existing conventional hydro-power schemes may be a rewarding solution.

The diagram Fig. 19 shows an arrangement the English Electric Company submitted to one of their customers to improve an existing low head scheme. The existing plant is equipped with three Francis turbines. An additional Dériaz pump-turbine "P" could be added. Pumping water during the night, whenever excess power is available in the system, increases the available peak load during the next day. It also maintains high water levels in the reservoir over a longer period, compared with conventional running conditions and improves conditions for power generation during the dry period.

Enlarging existing high head schemes by adding a pumping set is another solution worth considering. To some extent it may be possible to extend the scheme without increasing the physical dimensions of the existing dam, tunnel and galleries or shafts. It has been shown that there is a limit to such improvements, owing to additional friction losses in the conduits.**

Far larger extensions of existing schemes may be considered. The extension scheme for the *Loch Sloy* hydropower station near the city of Glasgow in central Scotland forsees a series of entirely new powerful pumping-generating stations, located underground, added to the existing conventional hydropower station. The existing dam would be the only item not to be duplicated for the pumping station, which capacity (up to 1 or 2,000,000 h.p.) would by far exceed the capacity of the existing hydro-power station (200,000 h.p.). The capital cost for the new pumping capacity would include only the galleries and shafts and the machinery. Base load power would be mainly excess nuclear power generated during the night.

Pumping Used to Increase the Potential Energy of Stored Water (Fig. 20, 21.)

The last example to be referred to is the *Pragnére* development in the French Pyrenees: water is pumped up 325m. into a reservoir and is then used for generation with a total head of 1,254 m. The economics of such a system, of which there are many examples in the Alps, is based on the increase of potential energy.

**This particular problem has been dealt with in a previous paper published in "Water Power", London, February/March, 1957.

[*Continued on page* 20

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PSIP 6

Flood Control Works in North Bihar

By P. R. GUHA

There have been frequent floods in North Bihar with consequent loss of crops and damage to land, property and life. This has become almost an annual feature. During the monsoons of 1953 & 1954, there was considerable damage due to floods and this was estimated at about Rs. 30 to Rs. 40 crores annually. It is recognised that the floods are not an unmitigated curse, but they serve a very useful purpose in enriching the soil and help in building up the country. Hence, they are to be tackled in such a way that their harmful effects can be mitigated as far as possible.

The North Bihar can be devided into three main zones, as each of them have got different flood characteristics and topography and each of them provides a somewhat different flood problem.

I. Gandak Valley

This zone extends from Gogra river on the West and Burhi Gandak on the East. This zone has more or less stabilised itself. This is due to the fact that the country has got comparatively flatter slope than in the two other zones. Three main rivers of this zone which carry the water from the hill catchment to Ganga are Gogra, Gandak and Burhi Gandak.

There are two basins in this valley one between the rivers Gogra and Gandak and the other between the rivers Gandak and Burhi Gandak. There are several small streams in between these rivers which also cause spilling as they have got inadequate waterway. These streams on account of being small are interfered with by local people either for irrigation or fishing purpose which affects their drainage when they are in high floods.

II. Adhwara or Central Zones

This zone extends from river Burhi Gandak on the West to River Kosi in the East. The Bagmati and Kamla are the two main rivers of this zone. The other rivers like Lalbakaya, Lakhandeyi, Adhwara, Dhaus etc., have got small catchments in the Himalyan regions. The rivers in this region have got very steep gradient and hence often change their course causing havoc to the country. This is aggravated by human agencies. The indiscriminate construction of embakments and constructing pynes without any regulating device cause the changes in the courses of these rivers as the gradients of the country are very much favourable for such changes.

III. Kosi Valley

This zone extends from river Bhuthi-Balan on the West to river Mahananda on the East. River Kosi is the main river in this zone. Almost all the rivers of central zone and Kosi meet together and fall into Ganga. River Ghugri takes all the discharges of these rivers to Ganga at Kursela Railway Bridge. The problem of this zone is being tackled by the Kosi Project Department.

1954 Floods, Formation of Control Boards and Technical Committee

Floods had been causing damage to life and property in various parts of the country at fairly regular intervals. The need for devising measures, immediate, short term and long term to minimise this damage was brought home by the extensive destruction caused by the floods of 1954 which were unprecedented both in their intensity and duration. The Ministry of Irrigation and Power, Government of India announced the formation of Central Flood Control Board vide their resolution No. DW14(7)/54 dated 8th September, 1954. The States which were liable to frequent floods were also requested vide the above resolution to constitute Flood Control Board to ensure that flood control measures were formulated and carried out expeditiously.

The Constitution and functions of the Central Flood Control Board are as follows:—

Constitution

1. Union Minister for Planning Irrigation and Power	Chairman
2. Union Minister of Finance	
3. Deputy Chairman, Planning Commission	
4. Deputy Minister, Natural Resources	
5. Chairman, Advisory Committee on Irrigation and Power Projects, set up by the Planning Commission	
6. One representative of each of the State Flood Control Boards, i. e. U. P., Bihar, West Bengal and Assam	Members
7. Secretary, Ministry of Irrigation and Power	Secretary
8. Chairman, Central Water and Power Commission	Addl. Secy.

Functions

(*a*) to draw up a comprehensive plan for Flood Control and fix priorities;

(*b*) to deal with matters relating to policy in connection with Floods and Flood Control Measures,

(c) to examine and approve specific schemes proposed for the investigation and construction of Flood Control Works in the States; and

(d) to arrange for necessary assistance in connection with investigations, planning and execution of Flood Control Works.

Accordingly the Irrigation Department, Government of Bihar announced the formation of a State Flood Control Board vide resolution dated 9th September, 1954. The Board constitutes as follows:—

1. Chief Minister	Chairman
2. Finance Minister	Members
3. Irrigation Minister	
4. Revenue Minister	
5. Development Commissioner	
6. Administrator, Kosi Project	
7. Secretary, Irrigation	
8. Chief Engineer (North)	
9. Chief Engineer, Kosi Project	

Secretary, Irrigation will serve as the Secretary of the Board.

The Bihar State Flood Control Board constituted its Technical Advisory Committee as follows, as suggested by the Union Ministry;

1. Chief Engineer, Irrigation (North)
2. A representative of Central Water & Power Commission
3. Director, Hydraulic Research Station
4. Chief Engineer, Buildings & Roads
5. Representative of the Railway in the State
6. The Chief Conservator of Forest
7. A Distinguished Engineer or other Official of the State to be nominated by the Chief Minister
8. Superintending Engineer, North Bihar Flood Investigation Circle. He will be the Secretary of the Committee.

Other Superintending Engineers of Flood Control Schemes in North Bihar can be invited whenever necessary.

Flood Control Works taken and Proposed in North Bihar

A. Along River Gogra: Schemes already taken up

There were existing embankments known as 7 nos. Bandhs along left bank of River Gogra constructed by local zamindars. These embankments were of inadequate section and often breached in high floods.

Accordingly the strengthening of these 7 nos. Bandhs for a length of about 33.0 miles was taken up at an estimated cost of Rs. 19.46 lakhs. The area expected to be benefitted by this scheme was 1,44,000 acres. This scheme has been completed.

B. Along River Bohta: Schemes already taken up

Due to back spill of River Gogra the areas lying on the banks of rivers Bohta and Daha get badly inundated. In order to prevent the areas fron flooding local people have constructed bundhs along both banks of river Bohta known as Deokuli Bundh. This bundh is not continuous and is of inadequate section. This causes spilling on countryside.

Accordingly a scheme has been prepared and taken up to remodel Deokuli Bundhs to standard section with a free board of 3'0" over H. F. L. for a total length of about 9.10 miles.

The estimated amount of this scheme is Rs. 6.65 lakhs and area expected to be benefitted is about 8,000 acres.

C. Along River Mahi: Schemes already taken up:

There were detached embankments known as Sitalpur-Brahnua bandh along both banks of river Mahi above Sitalpur Railway Bridge constructed by local zamindars. These were of inadequate section and often breached during high floods. The flooding was caused through the existing gaps also.

The main cause of flooding in this river was due to back water of River Ganga. Hence, to provide relief against the back spill of River Ganga a scheme for construction of embankment from out fall of Mahi into Ganga upto village Derni on the left and village Malahi on the right (where existing embankments end) for a total length of about 25 miles was prepared and taken up at an estimated cost of Rs. 16.35 lakhs. The area likely to be benefitted by this is 30,689 acres approximately.

D. Along River Gandak: Schemes already taken up:

There are existing embankments along both banks of River Gandak almost through out its leangth in Bihar from a long time. The embankments are known as Champaran, Tirhut and Saran Embankments in the districts of Champaran, Muzaffarpur and Saran.

The following Flood Control Schemes were taken up on this river in the year 1954-55.

Filling the Gaps of Champaran Embankment: This scheme provided to fill the gaps which were existing in the Champaran embankment along left bank of the river. The total length of all the gaps was about 20.0 miles. The estimated amount of this was Rs. 6.76 lakhs and the area benefitted 10,240 acres. This scheme has been completed.

Improvement of Saran Embankment: This scheme provided for raising Salempur Charki (taking off at 73rd mile of Saran Embankment) and Mangarpal Charki (taking off at 10.5 miles of Saran Embankment) to 4'0" above the H. F. L. of 1954. The estimated cost of this scheme was Rs. 1.23 lakhs. This scheme has been completed.

E. Along River Burhi Gandak: Schemes already taken up:

Marginal Embankments along right bank, of river Burhi Gandak from Panapur (about 20 miles upstream of Akharaghat Road Bridge) to Kothia Railway Bridge for a length of about 147.83 miles and from Akharaghat Road Bridge to Kothia Railway Bridge along left bank for a length of 136.70 miles have already been constructed till 1956-57.

Besides this we have taken up the following works in the year 1956-67 which are still under progress.

(*a*) Marginal Embankment along right bank from Panapur to Junction of Rivers Dhanauti and Burhi Gandak for a length of 42.60 miles.

(*b*) Marginal Embankment along left bank from a point opposite village Panapur to the Junction of Sijua nala and Burhi Gandak for a length of 53.30 miles.

After completion of these schemes we will have a continuous line of Embankment from Junction of River Dhanauti to Kothia Railway Bridge along right bank and from Junction of Sijua Nala to Kothia Railway Bridge along left bank except for a length of about 20 miles from a point opposite Panapur to Akharaghat Road Bridge which has been left till Bagmati spills are controlled.

Besides these, Back Embankments along both banks of rivers Bainti, Balan and Old Bagmati which fall in Bubi Gandak have also been completed.

The total length, estimated cost and area benefitted of the marginal embankments including Back Embankments along right and left banks are given below:—

	Length in miles	*Estimated amount in lakhs Rs.*	*Area benefitted in lakh acres.*
1. *Right Bank*			
(From Junction of Dhanauti to Kothia Rly. Bridge) including Back Embankment along river Bainti & Balan	230.13	314.78	6.70
2. *Left Bank*			
(From Junction of Sijua Nala to Kothia Rly. Bridge except between the point opposite Panapur to Akharaghat Road Bridge) including Back Embktt. along river Old Bagmati	216.20	296.71	3.34
	446.33	611.49	10.04

Schemes Proposed :

In addition to above a scheme for diverting about 3,000 cusecs of water from Burhi Gandak into River Gandak through Harha Nala amounting to Rs. 18.76 lakhs has been prepared and submitted to Government of India for their approval. This will benefit an area of about 52,700 acres.

The diversion cut takes off near village Basantpur about 22 miles above Chanpatia Rly. Bridge and just downstream of confluence of River Masan and falls through Harha Nala into River Gandak near village Dumdumwa.

The above scheme for diversion cut has been contemplated in order to reduce flood pressure on marginal embankments when the river is in high floods.

F. Along River Bagmati: Schemes already taken up:

(*a*) Marginal embankments from Hayaghat Rly. Bridge to village Sirsia for a length of about 42.0 miles along left bank and Hayaghat Rly. Bridge to village Karachin for a length of about 55.0 miles along right bank of river Bagmati have been taken up in the year 1956-7 and are under construction.

The estimated amount of the above schemes are Rs. 111.26 lakhs, and Rs. 77.88 lakhs and areas benefitted by them are 55,500 acres and 40,300 acres respectively.

(*b*) Besides these marginal bundhs, a scheme for checking the development of Sugia-Pardesia, Gonahi etc. spill channels of river Bagmati by constructing permeable groynes was sanctioned for Rs. 1.94 lakhs. This work has been completed.

Schemes Proposed to be taken up:

(*a*) Two more Schemes for marginal embankments along right bank of Bagmati from village Karachin to Saraiya and from Saraiya to Nagarpara embankment (just opposite Paharpur village), for a length of 47.0 and 12.75 miles respectively have been prepared and submitted to Govt. of India for their approval. The estimated amount of these schemes are Rs. 105.17 lakhs and Rs. 26.58 lakhs and areas benefitted by them are about 1,11,308 acres and 33,344 acres respectively.

After construction of these two schemes we will have a continuous line of embankment from Hayaghat Rly. Bridge to Nagarpara embankment (opposite village Paharpur) on the right bank for a length of about 114.75 miles and upto village Sirsia on the left bank for a length of about 42.0 miles.

(*b*) A scheme for constructing marginal embankment on both banks of river Bagmati above Dhang Rly. Bridge for a length of about 14.5 miles amounting to Rs. 15.54 lakhs has been submitted to Govt. of India for their approval.

This scheme has been prepared to check the river from diverting through spill bridges nos. 90 & 91 leaving Dhang Rly. Bridge No. 89 out of action.

(*c*) Another scheme for constructing 8.25 miles of embankment along left bank of Bagmati from village

Sirsia to village Phubia and about ten miles along right bank from SurmarHat to Hayaghat is under scrutiny.

G. Along Adhwara system: Schemes already taken up:

The first Flood Control Work in this basin taken up in the year 1954-55 was desilting of River Khirohi for a length of about 34.5 miles at an estimated cost of Rs. 50.43 lakhs. The area expected to be benefitted by this was 68,500 acres. This scheme is nearing completion.

This scheme comprises of desilting of River Khirohi from its off take near village Agropatti to its outfall in Darbhanga Bagmati to standard design sections capable of taking a discharge of 20,000 cusecs. The earth obtained from desilting will be utilised in making marginal embankments on both banks at a distance of about 900 ft. apart with a free board of 2'10" over design H. F. L.

The next work taken up in this scheme in the year 1956-57 was desilting and widening of the existing channel section of the river Adhwara-Jamura-Sikao and Burhad, all in continuation from junction point of Adhwara and Jamura to offtaking point of River Khirohi with varying bed widths in different reaches.

The estimated amount of this scheme is Rs. 68.24 lakhs and this is expected to benefit an area of 1,12,000 acres nearly.

This scheme has been prepared similar to the lines of Khirohi Scheme and the early obtained from desilting of the chennels will be utilised in providing marginal embankments on both banks having 2' free board over designed H.F.L. The embankments will be placed at a distance of 300 ft. from either edge of the designed channel.

H. Along River Kamla: Schemes to be taken up :

The construction of marginal embankments along both banks of the river Kamla-Balan from Indo-Nepal Border to Jhanjharpur Rly. Bridge for a length of 59.2 miles are in progress and nearing completion.

The sanctioned amount of this scheme is Rs 233.86 lakhs,

Schemes Proposed :

Another scheme for constructing marginal embankments along both banks of this river from Jhanjharpur Rly. Bridge to Darjia (its out fall in river Kosi) for a length of about 20 miles amounting to Rs. 50.42 lakhs has been prepared and submitted to Govt. of of India for approval.

A scheme for constructing about 6 miles of marginal embankment in Nepal along right bank of Kamla in continuation of right bank embankment under construction in Indian Territory is under examination. This scheme is to protects N. J. J. Railway Embankment from spill waters of river Kamla.

J. Town Protection Schemes: Schemes Already Taken Up :

Besides marginal embankments already described the following schemes to protect the towns from flooding and erosion were taken up and have been completed.

Chapra Town Protection Scheme: This provides for the construction of permeable groynes to protect Chapra Town from the erosion of River Gogra at an estimated cost of Rs. 1.04 lakhs.

Khagaria Towm Protection Scheme: This provides for the construction of spurs, bank pilings, bank pitchings etc. at an estimated cost of Rs. 2.25 lakhs to prevent Khagaria Town from the erosion of River Burhi Gandak.

Sitamarhi Town Protection Scheme: There was an existing ring bund to protect Sitamarhi Town from the floods of R. Lakhandeyi. This was overtopped and breached at several places during floods of 1954.

Accordingly a scheme was prepared at an estimated cost of Rs. 3.23 lakhs to strengthen this ring bund to standard section and raise it to 4'-0" above the 1954 H.F.L.

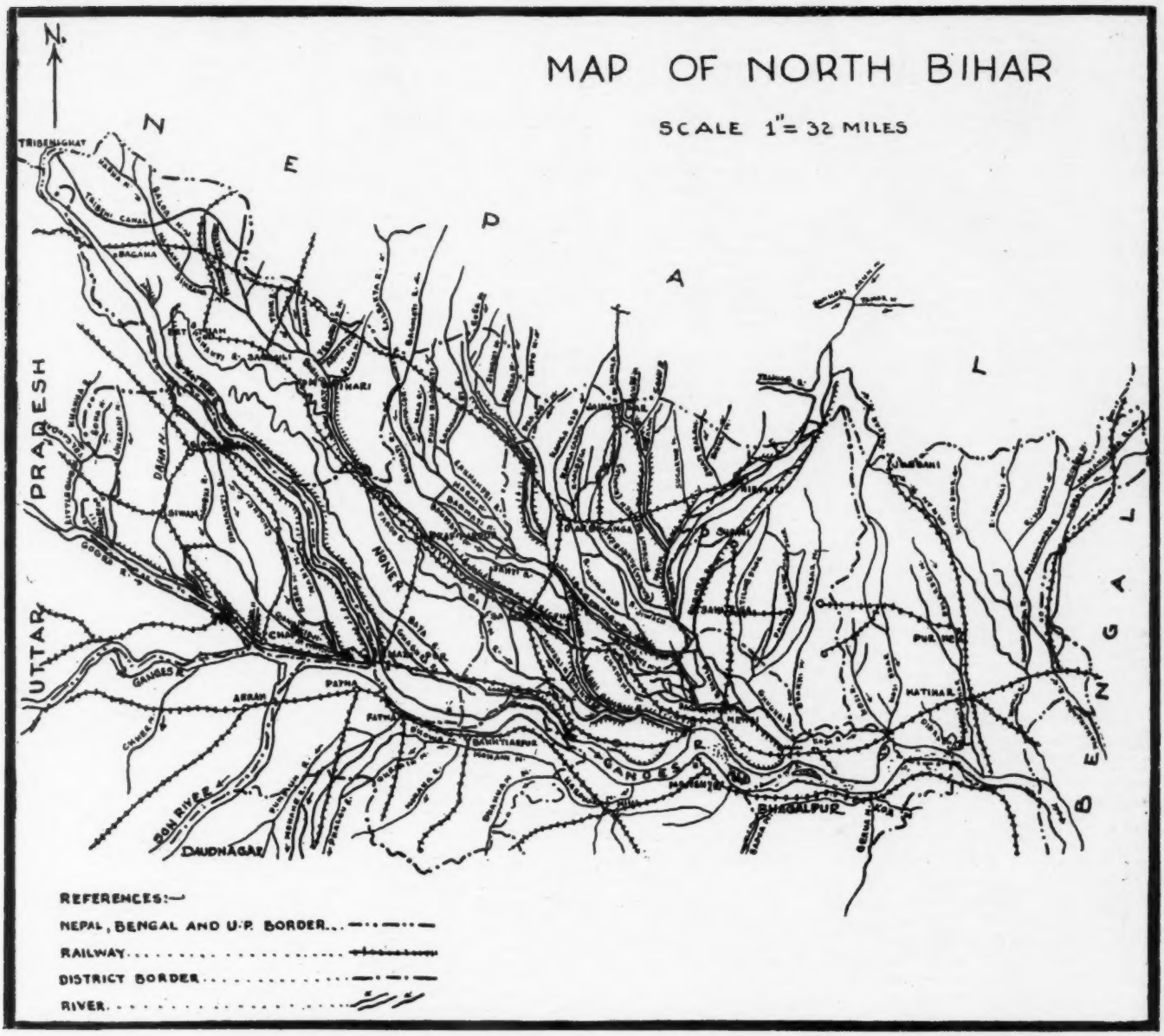
Estimated Amount of Works Taken Up

The construction of marginal embankments as described above was started in the year 1954-55 and upto the end of 1955-56 about 350 miles of embankment were constructed at a cost of Rs. 257.11 lakhs which protected about 6 lakh acres of lands from floods. In the Second Five Year Plan, an expenditure of Rs. 12.00 crores was planned for flood control During 1956-57 further 130 miles of embankments were constructed at a cost of Rs. 212 lakhs which protected about 7 lakh acres from 1956 floods. During 1957-58 about 220 miles of embankment were completed at a cost of Rs. 222 lakhs which benefitted an additional area of 4 lakh acres. The activities of the flood control works have been slowed down in the recent years due to non availability of funds. The financial target for flood control works has been raised to Rs. 7.90 crores, which is expected to protect an area of about 15 lakh acres. An expenditure of Rs. 160 lakhs is anticipated during 1958-59 for the consttruction of embankments, which is likely to ensure flood protection to further area of about 1.5 lakh acres.

A Master Plan for Flood Control Works in North Bihar has been prepared, which is under examination of the Central Water and Power Commission. The estimated cost is about Rs. 70.00 crores including the expenditures on the schemes already sanctioned. With the complection of the schemes as envisaged in the Master Plan, North Bihar would present a different picture altogether changing the present annual devastations into prosperity and security of life and property which will ultimately fulfil the ambition of the Government and the public, strengthen the economy and raise the standards of the People.

Construction Method through Public Cooperation

For speedy execution of the flood control works, it



was essential that maximum number of labourers available should be employed, as getting the heavy programme of earthwork involved in the Flood Control Schemes, executed by Earth Moving Machines was out of question. The possibility of doing this work through public co-operation by executing the work through the agency of "Mukhias of Gram Panchayats" was considered. The Council of Ministers of Bihar in their meeting held on 4th January, 1955 desired that the works will be let out to Mukhiyas of Gram Panchayats as far as practicable, but the total cost of any item of work should not go up on this account.

During the working season of 1954-55 and 1955-56 about 500 miles of embankments were taken up which involved an earth work of about 113 crores cubic feet. Out of these about 66% of the earth work was alloted to be executed through the agency of about 526 Mukhiyas of Gram Panchayats.

The total work done by Mukhiyas till April '57 was 48.11 crores cubic feet. It shows that works of about Rs. 1 crore were got done through 518 Mukhiyas till April '57. At one time about 25,000 men were working on Public Co-operative basis.

Mauvoisin Dam Building in Switzerland

By H. R. FIECHTER and L. WALTER

Claimed to be the highest arch dam in the world, the Mauvoisin project in the south-western part of Switzerland made extensive use of modern earth-moving equipment. Two electro-hydraulic power stations associated with harnessing of the river Dranse de Bagnes are now in operation (Fig. 1). This river comes from a glacier 7,300 ft. above sea level, and after travelling 28 miles descends to 1470 ft. and then joins the river Rhone. The Mauvoisin lake extends for 3 miles behind the dam. The catchment area of 73 sq. miles feeds the storage reservoir of 235 million cu. yds. capacity.

Arch Dam Design

Three different types of barrages can be used for forming storage lakes: (1) the earth or rockfill dam; (2) the gravity dam; and (3) the arch dam. The latter has been chosen at Mauvoisin due to excellent geological conditions. An arch dam is built in V-form. It requires very good rock foundations and solid rock flanks, supporting the dam on its sides.

For a dam having a height of 777 ft. and using over 2½ million cu. yd. of concrete, extensive studies and tests preceded the decision to use an arch dam design. Investigations disclosed that this construction was feasible.

Preparing Works for the Construction of the Dam

As one of the first things there was to be built an approach road to Mauvoisin consisting at the time of a small inn for tourists, an old chapel and nothing else. After this, the diversion channel was put under construction. It took the water of the Dranse river upstream of the excavation ground, derived it in the rock around the whole construction site and released it downstream of Mauvoisin. Soon after this, in 1951, the village for the workmen was erected. It consists of some 35 dormitories with the possibility of lodging about 1,200 men and has a big canteen, a tea-room, some offices, a new chapel, an infirmary, the post-office, etc. At the same time there were built distribution systems for compressed air, water and electric energy.

For pouring concrete the following installations were used:

1. *Gravel and sand:* Plants for its extraction, treatment and transport to the concrete tower.
2. *Cement :* Plants for the transport to the silo works and from here to the concrete tower.
3. *Concrete :* Plants for its fabrication and transport to the dam.

Gravel and Sand

The plain called Torrembe, which will later on represent the storage basin, contained enough gravel and sand suitable to the fabrication of concrete. But as the owner of the whole scheme swas very much interested in starting the storage of the lake as soon as possible, that means as soon as the dam would have reached a certain height, the extraction works were not permitted to last a long time. Therefore it was decided to transport the entire volume of some 4,000,000 cu. yd. on the downstream side of the dam and to store it here on an intermediate deposit. This work has been done with the help of excavators and big trucks of 16 cu. yd. capacity in 3 years and finished in 1955.

For the fabrication of concrete, the stored material was retaken by the excavators and hauled with the trucks mentioned above to the primary crushing plant, which can handle blocks up to a diameter of 2 ft. Here it falls through a grid into a primary silo work and by the means of a chain feeder regulating the quantity it is led to a vibrating separator retaining only the gravel with a diameter of 4.3/4"—23 in. Gyratory crushers bruise it to a size of 4.3/4" at most. Together with the already separated fine material it is hauled to the washing and separating plant by a large conveyor belt. Here it falls through a primary silo work into 4 turning washing machines, each of them feeding one street with a capacity of 130 cu. yd. per hour. Several vibrating screens separate the now clean gravel into the components 1/8—3/8; 3/8—1.1/16; 1.1/16—2.1/4; and 2.1/4—4.3/4 in. Sand recovery plants produce the necessary sand 0—1/8 in. As the raw gravel was quite poor on fine material, two additional sand crushers had to be installed. The so obtained 5 components are stored next to the washing plant. From here they fall through valves on the conveyor belt installed in the underground reclaiming tunnel below the deposits. This belt leads to the concrete batching plant through a zigzag-formed tunnel over a length of 860 yd. climbing 660 ft. The whole plant for the treatment of gravel and sand is built for an output of 520 cu. yd. per hour.

Cement

In the Swiss manufactories cement is put directly into 880 lb. containers and is transported by specially constructed railway wagons to the terminus at Le Châble in the Val de Bagnes. From here cement is hauled to the 4 silo works at Mauvoisin, containing 1,000 tons each, by means of a suspended cableway with a capacity of 60 t/hour, over a distance of 9 miles. At Mauvoisin the containers are

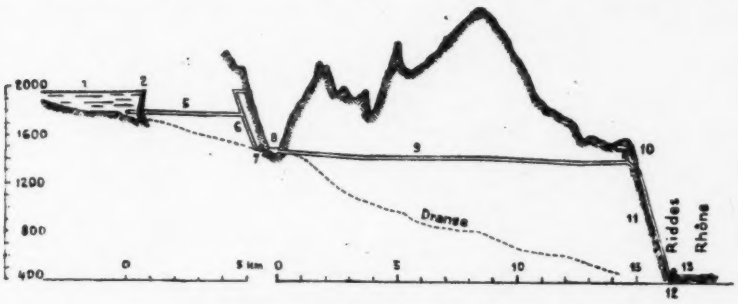


Fig. 1. The Mauvoisin Scheme

1=Lake, 2=Arch Dam, 5=Pressure Tunnel, 6=Surge Chamber, 7=Fionnay Power House, 8=Compen sation Basin, 9=Pressure Tunnel, 10=Surge Chamber 11=Pen stocks, 12=Power House, 13=Underground Tail Race.

emptied. The cement dust produced here is evacuated by a dust-exhauster. By infiltration of compressed air into the silo works, cement is made fluffy, then gets into the 2 pumps which blow it through a pipe-line to the concrete batching plant (tower).

Concrete

The top of the concrete town holds 6 material silo works purposed to receive the 5 already mentioned components and the cement. From here they slide into the automatic dosing plant which weighs each one, adds water and concrete additives and then lets fall the whole in a collecting funnel. The material then is led through a rotary funnel into five 4 cu. yd. drum mixers below it. After 90 seconds of mixing the machines are emptied into the 3 concrete hoppers hanging below with a capacity of 2×16 and 1×8 cu.yd. The whole concrete batching plant is working automatically and can be actioned and controlled in the central commanding room. The valves of the concrete silo works are about 21 ft. over ground, high enough to allow the 80 HP tractors to pull the especially constructed silobuses under them. so that they can be filled with 8 cu. yd. of mixed concrete. With this silobuses the mixture is hauled to 3 concrete buckets with the same capacity of 8 cu. yds. and emptied into the buckets by hydraulic opening of the valves. By means of 3 cableways with a lifting power of 20 tons each the buckets are transported to the dam. These cableways are fixed rigidly on the left-hand side of the valley, but on the right-hand side move on a 240 yd. long causeway enabling them to reach any point on the dam. The batching plant, the silobuses and also the cableways are built for an output of 400 cu. yd. of concrete per hour, or working for 20 hours with two shifts for a daily output of 8,000 cu.yd But in 1957 was reached a top performance of 10,500. cu. yd. of concrete poured in 21 hours.

The Big Blasts of Mauvoisin

Before the concreting of the dam could be started, the rock in the bottom of the valley had to be cleared and the excavation for the two abutments on the rock-sides finished. The classic excavation methods consisting of regular small blastings did not show a sufficient output, was quite dangerous, and therefore compromised the fulfilment of the program and made it impossible to work simultaneously on the flanks and the bottom of the valley, because the danger of falling stones was too big. Therefore a new method had to be found out and the following was decided:

Fig. 2. Details of the Mauvoisin Dam in Switzerland.
1 and 3=Injection Galleries for Sealing Works, 4=Natural Ground Level, 5=Lift Shaft, 6=Pendulum Shaft, 7=Injection Zone, 8=Maximum Lake Level, 9=Minimum Lake Level.

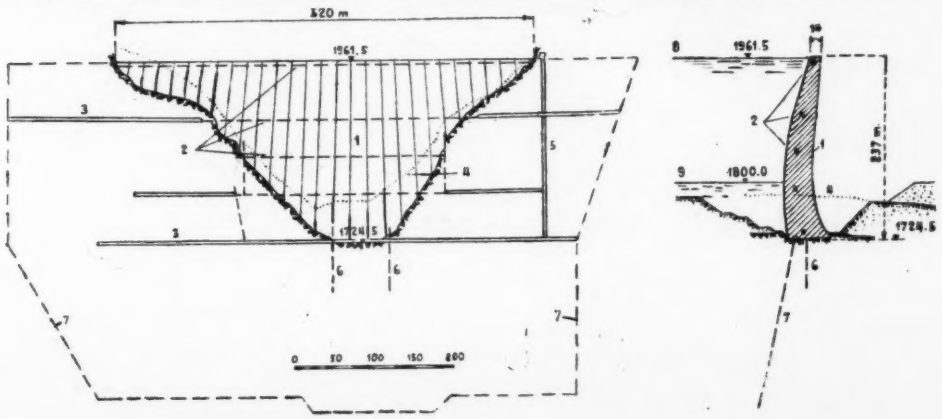


Fig. 3. First Stage in Dam Building: 1=Arch Dam, 2=Underground Powerhouse, 3=Sub-Station 4=Compensation Basin.

Starting from several platforms on the left and right-hand side a series of 3.3/8 in. holes were drilled in a direction parallel to the rock surface. Their top length was up to 460 ft. Using this method there could be worked on several different altitudes and simultaneously in the bottom and this even in wintertime. After the holes with a total length of about 4,900 yd. on the right flank had been filled with some 44,000 lb. of explosives, 90,000 cu. yd. of rock were blasted at once. This happened on November 11th, 1953. Excavators and the big trucks worked during 3 weeks only to evacuate the resulting 144,000 cu. yd. fallen rocks. On April 6,1954 followed on the left-hand side of the valley the second big blast with 6, 560 yd. of holes, using 70,000 lb. of explosives and putting off some 130,000 cu. yd. of rock. After the alluvium covering the rock in the bottom of the valley had been evacuated, several smaller blastings were done here, until we had a foundation excavation with a surface of 260×180 ft. and a depth of 160 ft. These enormous works lasted from September 1951 until August 1st, 1954. In total, a volume of 1,800,000 cu. yd. of rock and alluvium had been removed. On August 16,1954 the pouring of concrete into the dam could be started. (Fig. 5).

The Dam

The dam, the biggest work of the whole Mauvoisin scheme, has on the bottom a thickness of 175 ft., is 777 ft. high and its crest is 1,700 ft. long and 46 ft. large. Its concrete mass amounts to 2,635,000 cu. yd. corresponding to a cube with 430 ft. of lateral length. The dam is subdivided into 28 blocks with a width of 59 ft. each, measured in the longitudinal axis. These blocks are divided into "towers" and intermediate blocks, getting this way more pouring possibilities. After the concreting of a height of 10 ft on one block, concrete has to rest for about 36 hours to get the necessary strength for continuing the work. Dispersion of the 8 cu. yd. concrete heaps emptied on the block by the cable-ways, is done by means of small bulldozers and not by hand. This allows a more regular dispersial of the layers and helps to spare a few workers, a fact which is quite important today. To obtain a good and uniform density of the concrete and to make it lose the utmost of its water, it has to be vibrated after dispersion. This work is done with especially built electric vibrators in the shape of a needle with a length of 3 ft. and a diameter of 5 in., vibrating with a speed of 7,300 t/min. In the beginning, these machines weighing 150 lb. had to be actioned by two workmen pulling them in and out of the concrete, but as this work was too exhausting to be done continuously, it was tried to fix 4 vibrators on a small bulldozer. This system proved to be very rational, spared manpower and allowed to get a more regular vibration and therefore a better quality of concrete. To reach the desired density each cu. yd. of concrete has to be vibrated during 2.1/3 minutes.

Artificial Refrigeration of the Dam

The heat development due to hydration of cement depends mostly on the quantity of cement and amounts to about 160 BTU per 1 lb. of cement. In the first three days after pouring concrete, the temperature can rise up to 104°F. To allow the mass of concrete to shrink quickly and regularly, this heat has to be evacuated, i.e. concrete must be refrigerated. The most simple system of cooling consists in letting open breaches, closed only after the concrete has cooled itself down to the average annual temperature of the region. But this solution could not be chosen at Mauvoisin, because it would have retarded the construction program. So it was decided to use the artificial refriegeration. Every block after concreting a layer of 10 ft. is covered by a net of cooling pipes with a diameter of 3/4 in. a distance from pipe to pipe of 5-10ft. In these pipes cooling water with a temperature of 34-41°F is circulating, evacuating the heat so quickly that pouring of concrete can be retaken after 72 hourse.

In spite of this, concrete is shrinking a little more after it, producing small joint openings of about 1/8 in. These openings are closed after each concreting season by injections of grout. After this, the dam is absolutely compact and watertight. To avoid possible water leakage from the accumulation basin on the sides and below the dam, big grouting works in the rock had to be done. 1,100 yd. of galleries and over 37 miles of bore holes were necessary to do it. The sealing zone reaches 720 ft. below the dam bottom.

Fig. 4. The new Lake with the Dam at its end.

Emptying of the lake

To allow a quick emptying of the lake in case of danger, a bottom draining channel was built, with a capacity of 180 cu. yd. per second, this besides the already described pressure gallery leading to Fionnay. 520 ft. over the dam foundation to intermediate gallery has an evacuation capacity of 130 cu. yd./sec. A 3-part flood opening with a total capacity of 130 cu. yd. /sec. is constructed on the height of the dam crest. The catchment area being of 44 sq. miles and the maximum precipitation attaining 6 cu. yd/sec./sq. m., evacuation of highwater is assured by simultaneous working of the intermediate and the top evacuation galleries, rendering impossible an overflowing of the dam crest. All three of these evacuation installations lead the water to the downstream side of the dam, where the Dranse retakes it, flowing its normal way through the valley. We note that by means of all evacuation galleries including the pressure gallery the lake could be emptied in about 6 days.

Summary

The most important technical data:

Lake:	
Superior level of the lake	6,435 ft.
Inferior level of the lake	5,905 ft.
Useful volume	235 million cu.yds.
Dam:	
Arch dam, height	777 ft.
Length of the crest	1,700 ft.
Width of the crest	46 ft.
Width of the bottom	175 ft.
Mass of concrete	2,635,000 cu. yd.
Power-house Fionnay:	
Gross head, max	1,580 ft
Gross head, min	1,030 ft.
Capacity, max. (3 groups)	127,500 kW.
Capacity, min. (3 groups)	82,500 kW.
Power-house Riddes:	
Gross head, max.	3,385 ft.
Gross head, min.	3,344 ft.
Capacity, max. (5 groups)	225,000 kW.
Yearly output of energy:	
Winter-time	604,000,000 kWh
Summer-time	157,000,000 kWh
Total	761,000,000 kWh

The dam including the street on the crest has been finished in November 1957. In the power-house at Fionnay the third group is actually being installed. The power-house at Riddes is producing the precious electric energy since already a few months.

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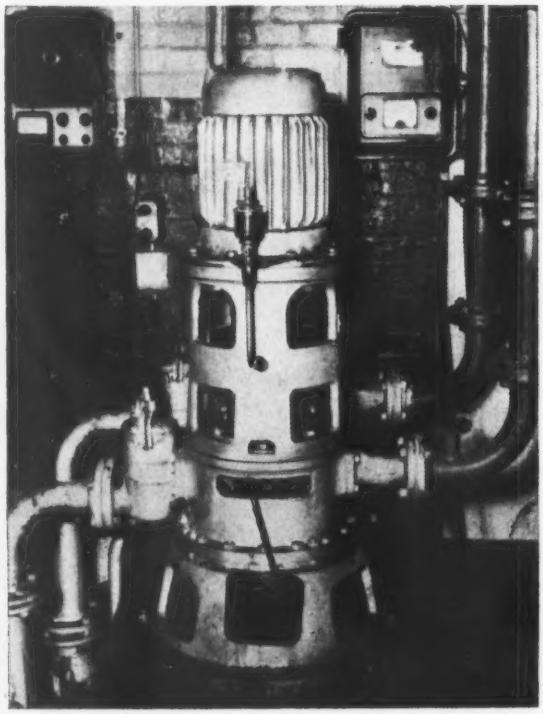
Pumps for New Processes

By M. H. L. WHITEHOUSE

With the introduction of new chemical processes, the rapid development of nuclear engineering and the general trend towards compact plant construction, came the need for further advances in pump design. Not only were pumps now required to handle fluids of higher temperature and greater viscosity at a much faster rate, they had also to be constructed in a manner that would allow maintenance to be kept to a minimum and replacements, if needed, to be simply and easily made. Requirements such as these are reflected in the designs of many of the forty pump manufacturers, who were exhibiting at the Engineering, Marine, Welding and Nuclear Energy Exhibition (held at Olympia from 16th to 30th April, 1959).

Typical of the new designs of pumps, now widely used in the nuclear and chemical industries, are those produced, after much research, by the British LaBour Pump Co. Ltd . of London. These pumps are called upon to handle a great variety of fluids, some of them highly corrosive, at many different temperatures and pressures. They are made in various different materials according to the fluids they are required to deal with. For example, bronze pumps are used for acetone and alcohol; aluminium pumps for hydrogen peroxide and formaldehyde.

British LaBour G-type vertical pump for handling works effluent with a pH range of 3—12 before treatment.



One of the new LaBour designs (known as the SZ model) is a single stage, single suction non-priming pump for all types of liquids and slurries. It has a fully open type impeller separable from the shaft. Pump back, impeller and motor can be withdrawn in one unit without disturbing suction and delivery pipes.

Another horizontal centrifugal single stage pump—the LaBour MSZ model—has been specially designed for handling corrosive and non-corrosive hot or cold liquids with capacities up to 1,000 gallons per minute and heads up to 300 feet. In this pump the casing is vertically split, so that the whole rotation assembly can be withdrawn without disconnecting suction or delivery pipes, disturbing the driving motor, or upsetting alignment.

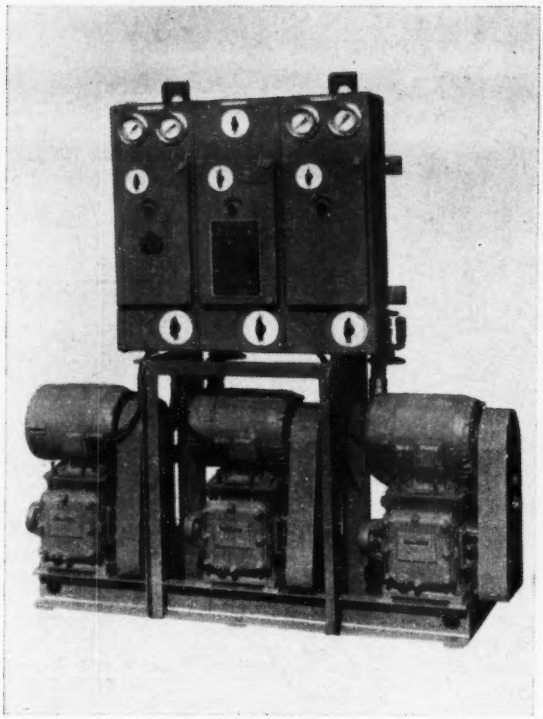
The British LaBour company also showed at Olympia their self-priming pumps (UHL/UPL model) which are available in a wide range of corrosion and erosion resisting materials, including the company's special nickel alloy, R. 55; a pump (SCHL model) which will extract liquors under 28 inches of vacuum and incorporates a seal-bath, totally immersing the gland to prevent air-entry when running under vacuum conditions; and a self-priming pump (USL model) for use in mines, which has a mechanical seal that needs no lubrication or external cooling.

The latter pump will run for long periods on "snore" and does not require a foot valve.

The trend towards self-contained pumping units for marine purposes was illustrated at Olympia by many of the exhibits shown by Megator Pumps and Compressors Ltd.

Megator pumps for marine diesels using heavy fuel oil will be shown in a new fuel-valve cooling unit that combines pump, controls and the associated tank, including heating and cooling coils. This offers uniform standards of installation and easier maintenance, both of which are important for shipboard plant.

Modern ships present a variety of pumping problems, and a single design of pump available in various sizes and adaptable by using components in different materials, is particularly useful. These pumps can



One of the range of prefabricated Uuit Pressure Sets for marine water systems introduced by Megator Pumps and Compressors Ltd.

handle almost any liquid from fresh-water tc Bunker "C" oil.

The basic design of the Megator pump, which is also used in industry and mining, provides a positive displacement with high suction lift, yet offers the advantage of operation without valves and with automatic compensation for wear. It has few moving parts, and these are simple and robustly designed, consisting of three plastic or rubber sliding shoes within which the liquid is drawn by means of the oscillating motion (relative to the shoes) of eccentrics disposed on the main drive shaft. Valve action is provided by ports in the shoes and port-plates. This basic mechanism is suitable for dealing with liquids of widely varying viscosity, including chemicals and food substances.

Another firm of pump makers, who pride themselves on the variety of materials which they can deal with, are the Comet Pump and Engineering Co. Ltd.

One of the difficulties in preventing the pollution of sea water by oil fuel discharged from ships' tanks is that centrifugal separators used for purifying bilge water before it is pumped overboard, are unable to extract oil which has been broken up by the bilge pumps into globules of less than 8/1000 inch in diameter. Positive action Comet pumps are among the few which are capable of delivering oily ballast water to the separators in a condition which they can handle. One of the most successful model is the little "Dinkum" $\frac{1}{2}$ inch ($\frac{5}{8}$" holes) $\times$ $\frac{1}{8}$ h.p. pump, whose main use is for fuel oil sludge disposal, though it can also deal effectively with sewage and the like.

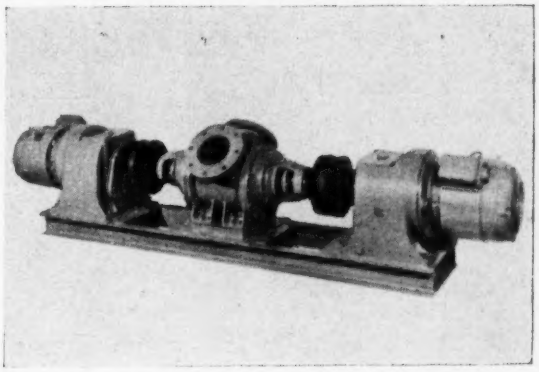
At the Engineering, Marine, Welding and Nuclear Energy Exhibition, positive action and totally reversible pumps, able to deal with all manner of liquids, solids such as wood bark or grain, and semi-solids like liquiorice, clay, cotton waste, wood pulp and rubber surgical dressings, was seen on the Comet stand.

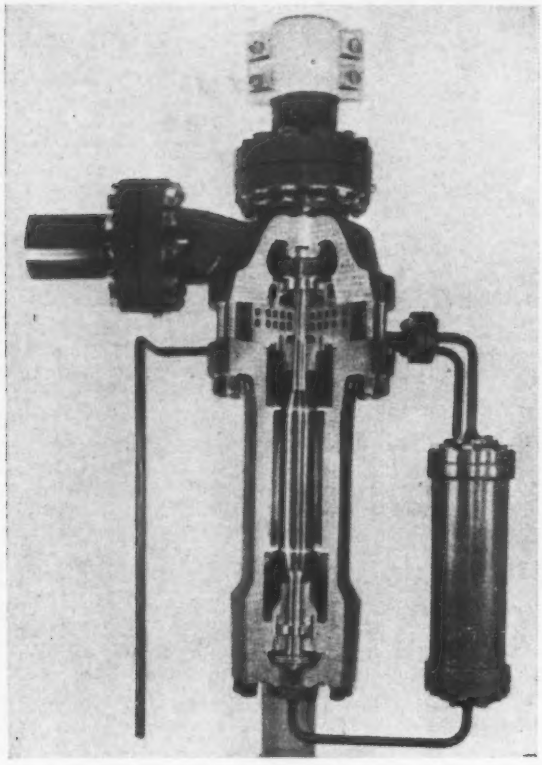
Pumps from Britain are found in every country in the world, and annual exports amount to more than £16 million each year. But not only British pump manufacturers will be showing at Olympia; one foreign firm—the K.S.B. Manufacturing Company, of Germany—will include among their exhibits pumps for steam power stations and marine engineering, as well as pumps specially designed for the chemical industry.

K.S.B. multi-stage boiler feed pumps, developed for very high pressures and temperatures, have been giving satisfactory service at pressures of 5,800 pounds per square inch (gauge) and temperatures of 310°C. Their expansion—compensated casings make them suitable for rapid and frequent starting at high temperatures.

In the K.S.B. glandless circulating pump, the pump and motor are combined to form one unit in the same casing. Over heating of the motor is prevented by a thermal barrier between the pump and motor compartments. This allows the pump to operate efficiently at temperatures upto 400°C. It is used in steam boiler plants, cooling water systems, nuclear energy plants and similar applications, where suction pressures up to 3,600 pounds per square inch (gauge), capaci-

Comet Pump and Engineering Co. Ltd. 6" double-drive go-devil with two 7½ h.p. geared motors for handling molasses.





Glandless Circulating (K.S.B.) Pump LUV, Cut-away model.

ties up to 3,700 imperial gallons per minute, and heads up to 330 feet are encountered.

These pumps are manufactured in a variety of materials for any liquid or liquified gas. They can be fitted with a normal stuffing box or a mechanical seal, and thoroughgoing standardisation has removed the need for extensive stockholding of spare parts. Special vertically arranged canned motor types, which are leak-free at pressures up to 5,700 pounds per square inch (gauge) with temperauters up to 400°C. are available.

At Olympia, K.S.B. were also shown marine pumps suitable for cooling water, ballast or bilge handling. These may be self-priming or otherwise, and vertical or horizontal, with capacities up to 5,500 imperial gallons per minute and able to accommodate heads up to 115 feet.

Gilbert Gilkes & Gordon Ltd., of Kendal, Westmorland, will include among their new exhibits the AXIPEL range of fullway silent circulators for heating systems, the GILPRIME multi-stage self-priming pump for heads up to 700 feet and capacities of 600 gallons per minute, and the CENTURI M.S.P. centrifugal multi-stage pump, which is similar to the GILPRIME, but without the self-priming stage.

Also new were the Gilkes CENTURI E.M. range of pumps in sizes from 1 inch to 3 inch pipe branches giving outputs of up to 500 gallons per minute at heads up to 200 feet.

The design of the AXIPEL silent circulator provides complete isolation of the pump from the motor and full bore gravity flow when the pump is not operating. A face type mechanical seal prevents contamination of water with oil and requires no adjustment. The pump operates in horizontal, vertical or angular pipelines, and is automatically lubricated in any working position from a large capacity oil reservoir. The unit connects directly into the heating mains, requiring no special foundations.

Continued from page 7

Economics of Pumped Storage

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NEW V-BELT DRIVES

The narrower, high-speed belts pack up to three times the horsepower capacity in the same space. This new V-belt has several advantages because of the space it saves. The concentrated strength of these narrow belts allows using narrower or smaller diameter sheaves. Also, the lower ratio of width to thickness explains how this new type belt can transmit up to three times more horsepower in the same space needed by the conventional V-belts. An arched top, chemically bonded tensile cords, and a more flexible cover are other reasons for the increased ratings of the belts. —*Gates Rubber Co.*,

Glimpses of Water-Conservancy in China—II

(Concluded from the May issue)

By S. SESHADRI

Dam Projects

In recent years, considerable activity has been going on in the field of Dam Construction. Many dams have been built during the last 8 years, being mostly of concrete and earth. In concrete different types of dams have been built, such as :

(*a*) Gravity Dams: The Sanmen gorge dam, across Yellow river, 100 metres high (work just started).

(*b*) Arch Dams: Shavhungdiyan dam, 84 metres high, across a tributary of Hvai river (work nearing completion).

(*c*) Multiple arch Dams: Futzeling dam 74.4 metres high and Meishan Dam 89 metres (289.5 feet) high, both across tributaries of Hvai river. The works are already completed.

(*d*) Big head type hollow buttress gravity dams: Mozetan dam, 82 metres high, across a tributary of Hvai river (work nearing completion).

Meishan multiple arch dam is claimed to be highest in the world (289.5 feet), higher than the Bartlett Multiple arch dam 286 feet high, in Arizona, United States.

Earthen dams: Kwanting Dam 45 metres high across Yungting river (work already completed). Tahofang Dam across Hun river, 48 metres high (work nearing completion).

Rock-fill dam: Se-je-tan dam 52 metres high. Work already completed. In addition some other dams have also been built.

The noticeable feature is that, all these dams have been constructed within a short period of 8 years, so that the speed of dam construction achieved is rather appreciable. For instance, the Futzeling and Meishan dams were constructed in "a little less than 2 years' time each". Works completed till now were done predominantly by labour, with machines being used sparsely, but now the construction work of the Sanmen gorge is completely mechanised.

Construction work is generally done almost throughout the year and as far as possible in 3 shifts per day, starting from the foundation excavation up till the finish. All the works are done departmentally, so that the quality of works is generally high. Coupled with these and by proper organisation of labour employed on works, the speed of construction that has been achieved is quite appreciable.

At the project sites, to be able to carry on with the work of concreting almost throughout the year, protective overhead coverings are arranged over important places, such as :

Coverings of bamboo matting over the entire aggregate supply line from the quarry store to the mixing plant and over the finished concrete supply line from the mixing plant to the Dam.

Canvass covering over the entire area of concreting, in the dam including the concrete lifting devices, say the vertical towers or coal mine type elevators, etc.

The entire mixing plant, which is usually constructed in 4 tiers, being :

Top tier for the temporary storing of cement and feeding to the mixers.
2nd tier, for the aggregate supply lines
3rd tier for the concrete mixers and
the last tier, for the finished concrete supply trolley line, will be roofed over, completely so that the work may not hampered due to rains.

At the Shavhungdiyan project, to save time in the erection of the generating units of the construction power house, readily available small capacity Diesel generators, such as

1 unit of 220 kW.
2 units of 400 kW.
1 unit of 440 kW.
1 unit of 600 kW.

were used instead of waiting for a large capacity set. This has got the added advantage of economising power, in being able to shut-off one or two units, when full load is not there.

Design of "light type structures" such as, say, arch dams, hollow dams, multiple arch dams, also contributes towards the speed of execution. For instance, the lift for concreting used at the Shavhungdiyan arch dam is 5 metres, whereas, in a gravity type construction, such lifts will not be suitable, due to the difficulty of "internal heat dissipation", but in case of light type structures, heat dissipation is comparatively easier.

For concreting of dams, various devices are used, such as, at Sanmen gorge, after an economical comparison of different alternatives, movable steel tower cranes with long arms and of capacity up to 15 tons,

are to be used. The length of the arms of the crane is long enough to cover the entire width of the dam section.

At the Shavhungdiyan arch dam, coal mine type elevators, with a bucket capacity of 0.8 M^3, worked by electrically operated winch, are being used. The elevator is fixed to the back of the dam itself and the whole mechanism is raised gradually, as the dam rises.

At the Mozetan dam, the hollow portion of the buttresses has been advantageously used for installing the concrete lifting equipment. In this case it consists of a vertical steel tower, supported on the walls of the buttress itself. Along the steel tower, moves a bucket of 1 M^3 capacity, operated by an electrical winch, from the bottom. On both the flanks, concrete is raised to the top in buckets of 1M^3 capacity, moving along inclined trolley lines, laid on hill slopes, worked by electrical winches from the top.

At both the places, during the initial stages, small cranes of 5 tons capacity, were used to place concrete.

At the Sanmen gorge project site, for the "construction power", instead of the Diesel generating sets, they are using "The train power house" for supplying the construction power, during the initial stages.

Actually, "Train Power House" is a specially built train to accomodate all the components of a thermal power producing unit, operated by a steam turbine. The various components such as:

(1) Boiler unit
(2) The Steam turbine unit
(3) The Generator unit
(4) The Switch Board panel unit
(5) The Transformer unit, and lastly
(6) The cooling unit, for cooling the water, used for the "Generating unit".

All these various units, are neatly accommodated in closed type specially built carriages. Actually, the train is composed of 7 carriages, 6 for the generating equipment and one for the operating staff. It is a broad gauge train, so that, it can be taken to any place, just like an ordinary train.

This "movable power house on wheels" can be easily worked at any place, even in an out of the way place, such as the usual case with a dam-site, the only additional requirements being, sufficient stock of coal for the boiler and water for the boiler. This has got the following advantages:

1. The working cost is economical than diesel generating units.

2. In the beginning stages of construction, when other generating equipment may not be readily available, this can conveniently be used. It is not necessary to lay the track up to the dam site, but this train can be stationed on the nearest existing railway track. Only a short distance of transmission line will have to be laid from the train power house to the project site. When its use at one place is finished, it can be transported to any other place, as a compact train, all the units being packed neatly in their respective carriages.

The capacity of the Power House under reference is 2500 kW. and is made in Czechoslovakia. This is being continuously used since the last 8 months, stationed at a place about 18 miles from the dam site. I learnt that there are also such Russian made "movable power houses" of capacities up to 4000 kW. This type of "Power House on wheels" is a great asset to any big project work.

For the design of dam projects, especially for the collection and analyses of hydrological data, fixing up of various levels of a reservoir and deciding its benefits, methods, based largely on Soviet techniques, are used. As a result, for the collection of silt samples and hydrological data, a method known as "slant navigation method" is used. The reservoirs which have been completed till now at mostly designed as "flood control reservoirs" reserving a considerable capacity, for retaining the flood waters each year. For the design of Earth dam "The sliding scale method" is used, such as the case of Kwanting earth dam, 45 metres in height.

To have good check over the quality of construction at all dam sites, field laboratories are established. The experiments and tests on concrete are done in "constant temperature and constant humidity rooms". Also before starting the actual construction work, considerable "hydraulic model studies" are made to decide such factors, as:

(1) Position and size of sluice tunnels
(2) Profile of overflow sections
(3) Uplift pressures on foundations of structures on sandy beds—for this the "electrical analogy" method is used.
(4) Suitable energy dissipation devices, etc. etc.

As such, at the Futzeling and Shavhungdiyan dams, for the energy dissipation below sluices, the "shooting water jet" method is used. The water jet shoots up to 100 metres is length, in the form of a projectile and on its way, the energy is dissipated by the action of atmospheric pressure.

At the Nanking Hydraulic research laboratories, an interesting experiment is being done, using the "wind tunnel method" to decide the "angle of take off" in the case of major irrigation canals, for, the smoothness of flow and scouring action etc. largely depend up on the "take-off angle".

"Structural model studies", for finding out the actual state of stresses and strains in a dam section etc., under different conditions of loading, are not being done much. But nowadays, it seems, this is the trend in dam design in European countries, especially in Italy and France. Theoretical analyses, however,

elaborate, do not give an accurate idea about the state of stresses and strains inside the body structure. Structural model studies, help not only in accurately finding out the state of stresses and strains, but also make the design work easy, by lessening the amount of analyses work. For instance, in Italy, for the design of concrete "arch dams", instead of the usual "trial load analyses" method, which involves lot of calculations, they first find out a rough section, by analysing the arch dam, as a series of simple horizontal arches and by the "structural model studies" fix up the final section, thereby saving a lot of time required for the laborious calculation work. The section thus arrived at, is more reliable also.

At the Futzeling multiple arch dam which is now complete and producing power, pipe sluices 2 metres in diameter, placed in the hollow portion of the buttresses, are used for the discharge of flood water. Due to shock of flowing water under high heads, usually pipes begin to vibrate, which, if more than the allowable limit, may prove dangerous to the pipes. To record and measure the vibrations whenever water is let down through the pipes, an interesting instrument made in East Germany is being used.

This instrument can be worked by electric current using a combination of battery cells. This automatically records on a graph paper, both the magnitude as well as the frequency of vibrations. For the maintenance work of the pipe sluices, this instrument is very useful.

At the Mozetan hollow buttress dam, for the concrete lining of the "pressure tunnels" a special form of "formwork" called as "vacuum formwork", is being used.

Mixing water of concrete, usually contains some extra water more than what is actually required by the cement, which may be called as "workability water". If we are able to take out or absorb this amount of water, from the concrete, after it is placed, we can produce a comparatively denser and stronger concrete.

In ordinary cases, this is not easily practicable and also not necessary. But in pressure tunnels, through which water under high velocity always flows, this problem is very important i. e. the problem of making the concrete of the lining more dense and strong, so as to be able to better withstand the eroding action of high velocity water. This is usually done by using "absorptive form work" or as in the present case, by using the "vacuum form-work". By using this type of form work, the surface concrete of the lining, which comes in contact with high velocity flowing water, can be made denser and stronger.

The method consists in sucking out the extra amount of water from the surface concrete by vacuum pressure, through this "vacuum formwork", immediately after the concrete is placed.

The formwork is of wood, the size of each piece used being 191 centimetres × 46 centimetres. Each formwork has 2 holes, fitted with a short length of nozzle, on the bottom face. To each of these holes, is attached a rubber tube, the other end connected to a manifold, which in turn is connected to a water receiver whose other end is connected to the vacuum pump. Immediately after the concrete is placed, absorption is started. The extra water is sucked out through the holes in the formwork, by the vacuum pump. The absorption is done for about 30 to 45 minutes, after which it becomes difficult, since the concrete starts setting. But this will be enough for our purpose. About 8% of water can be sucked out by this method, from the face of the lining, so as to make it more dense and strong. It seems by this method, the strength of the concrete increases by 20%. Vacuum pressure used is about 250 m. m. of mercury and roughly about 5 k. g. of water is sucked out from each square meter of lining. Formwork can be removed soon after the sucking is over, as the concrete becomes sufficiently strong, due to which, lining work is done quicker. This method also economises the use of cement for tunnel linings, which otherwise require a very high cement content, to produce a dense and strong concrete. The thickness of lining used is 40 centimetres and the finished diameter of tunnel is 5.7 metres, capable of discharging 600 cubic metres/second. Concrete, for the top portion of the lining is placed by a "concrete pump".

At all construction sites, "economy" has become the "watch word". During construction, utmost economy is aimed at to reduce construction costs . This may be in the design of the project, such as trying to use less of steel and cement or in the proper combination of human labour and machinery to get speedy results economically, or in the use of construction materials, especially steel and cement.

Admixtures are always used with cement to reduce cement consumption. At Shavhungdiyan and Mozetan dams, fine ground puzzolona is used as admixture, up to 25%. Plums are also largely used while concreting. This has also got the added advantage in reducing the "heat of hydration" of cement.

Aggregates for concrete are usually collected from the riverbed itself instead of quarrying them. This has been done in almost all the cases, such as Futzeling, Mozetan, Shavhungdiyan and even in the case of the big Sanmen Gorge dam, whose total amount of concrete is 3 million cubic metres.

It is claimed that, that cost of collected aggregates is about 12% to 15% cheaper than that of quarried aggregates and in case of big dams, this may work out to an appreciable amount. This has got the other advantage in that both stone and and can be collected simultaneously.

Wood is predominatly used as far as possible for all purposes, such as :

For supporting trestles and supporting platforms mainly wooden ballies and bally trusses are used

instead of steel and even temporary bridges etc. required for transport of materials during the construction are also of wood.

Temporary housing put up at the project sites, both for officers as well as labour, are all simple bamboo huts with thatched roofings so that the materials, after dismantling, can easily be used at some other place.

As the dams being built are "light type structures", such as hollow dams, arch dams, multiple arch dams, elaborate cooling arrangements are not found necessary. By this also, construction costs could be economical. Also, these "light type structures" require a fairly lesser amount of cement when compared with heavy gravity type structures. This type of construction suits advantageously for India, where the scarcity of vital construction materials especially of cement is more.

Nowadays, use of "light weight structures" is the trend in Dam building in European countries and in U. S. A. where the gravity type of structures are almost becoming outmoded.

In designing concrete mixes for dams the property that "strength of concrete increases with age" is advantageously made use of, in lessening the cement content of the mix, such as :

Strength of concrete of 90 days' age is more than the strength of concrete of 28 days' age. If we want to get the same strength, at 28 days' age itself, we will have to increase the cement content of the mix which means that the cement consumed will be more. On the other hand, usually in dams, we can easily afford to have the interval of 90 days or even more before that particular portion of concrete is stressed to its designed valve. So this property is advantagenusly made use of while designing the concrete mix, to reduce the cement content. Only thing, we will have to continue the watering of concrete to a longer period i.e. say 90 days instead of 28 days, which, is more economical, when compared to the increased cement content of the mix considering the age as 28 days. This can be clearly seen, from the "Mix design" used for the Shavhungdiyan arch dam.

Strength	*Cement*	*Puzzolona*	*Sand*	*Stone*	*W/C Ratio*	*Water*	*Air Entraining Agent*
170 k.g./cm² at 90 days	148	30	430	1950	0.6	110	.0125
140k.g./cm² at 180 days	125	36	346	1950	.71	102	.01

Materials are in kilogrammes per cubic metre of concrete

Irrigation

Now days, much attention is being paid to the scientific development of Irrigation in all its aspects including the :

Hydraulic structures involved

The canal system (for irrigation and also for drainage) and perhaps the most important of all being, the ensuring of the proper use of Irrigation water, which also takes into account the maintenance part of the canal system.

For diverting water for irrigation in addition to dams, simple methods are adopted as per circumstances, such as :

In Yellow river, which is an elevated river in its lower reaches, water is diverted, without having any structure on the main river course, by only having the canal head works along the river, e.g. People's Victory Canal Head Works capable of diverting 80 M^3 sec. At present, head works of 200 M^3/sec capacity, also have been built. On the same river, the difference of head between the elevated water level and the adjacent ground level is taken advantage of in having a number of siphons for diverting water. In Hvia river basin also, similar head works capable of diverting 700 M^3/sec. For irrigation, are built along the Hungtze lake which has been made to act as a natural reservoir, by surrounding it with dykes.

In the design of irrigation canals to find out accurately the irrigation water requirement of crops, careful analyses of the rainfall data is made, taking into account the amount of rainfall in the crop season of the particular crop, such as :

Rice
wheat
cotton, etc.

whose growing seasons are different.

Coupled with this and also by the actual data of Irrigation Experimental Research Stations, established in each of the big irrigation areas, it has been possible to achieve a fairly "high duty of water" for different crops, such as

Rice—25″ or 88,000 c.ft./acre
Cotton—10.5″ or 36,000 c.ft./acre
Wheat—11″ or 36,200 c.ft./acre

By the Irrigation Experimental Stations using their actual data of water requirement for crops based on the type of soil of each area, good economy can be achieved in the use of irrigation water and also, the per unit area yield of crops can be increased with the help of experiments, such as :

(1) The suitable manure to be used
(2) The type of crop rotation
(3) The use of suitable seeds
(4) Suitable farming methods etc.

Yields like

Rice—2300 lbs/acre
Wheat—900 lbs/acre
Cotton—1000 lbs/acre (seeded)

are common in irrigated areas.

Another very important factor, that is being paid much attention to, in achieving economy in the use of irrigation water is in getting the co-operation of peasants in using the irrigation water carefully. In many of the irrigation areas, peasants themselves have been made mainly responsible for the maintenance and the up-keep of the smaller "field distribution network" of canals, thereby minimising to a great extent any waste of water on account of the bad condition of field canals and, as far as the major canals are concerned, regular maintenance is done by a separate "management bureau" establised in every irrigation area.

During the watering period, a team consisting of representatives of "peasants" and the "management bureau" keep a close watch on the condition of canals, closing or opening of field outlets, operation of branch canal inlet gates, condition of pumping/equipment, if any, etc. which is another important factor in economising the use of irrigation water and this also avoids any possible disputes that may arise over the use of irrigation water.

To get better results by irrigation, proper drainage of irrigation areas is by no means an unimportant part. As a result, invariably each of the big irrigation areas has a well planned system of drainage canals, that too, especially in the more rainfall areas, for, the success of irrigation depends much on the supply of required amount of water at the required time, which indirectly implies that any extra water in the fields must be drained out.

Proper drainage of irrigation fields has got the added advantage of lowering the ground water level which helps a lot in preventing the waterlogging of the fields, especially those, having soil of very poor drainage property, such as "The black cotton soils. Good drainage also prevents the irrigation fields from becoming "alkaline" due to the rise of ground water level. At many places, where drainage by gravity is not feasible, pumps are being used to drain out the water, collected at a central place.

In the design of canal system, while fixing the suitable alignment of canals, especially the field channels, the type, performance and efficiency of the "Farm machinery", are also considered, so that based up on the advantageous and effective use of farm machinery such as ploughing tractors and other small mechanical equipment that may be used during the growing season, the bigger units of the field distribution system, are suitably designed and spaced.

The last but not the least factor in getting good results from "Irrigation" is the close co-operation between the "Irrigation" and "Agriculture" departments. For an efficient design of Irrigation project, good help of the agriculture department is quite essential. This cooperation is required not only for the design of Irrigation project, but also for the future operation and maintenance of the Irrigation area, so as to secure the maximum benefits.

This point has been well recognised in China, in as much as, one can see both Irrigation and Agriculture personnel, both in the "Irrigation area Management Bureau" and also in the "Irrigation Experimental research stations" so that, by a correlated work of these two closely connected departments, full benefits due to Irrigation are being achieved. This is also the main reason for the development of "Co-operative Farming" on a very large scale in China. Co-operative-farming is the sure and best method of getting maximum benefit from Irrigation, because of being able to carry on irrigation on a large scale very scientifically, thereby increasing the production from the land to a great extent. If the farming is done individually involving very small areas, "irrigation" cannot be done efficiently than when the farming is done on a co-operative basis involving large areas. There are Co-operative Farms of the order of 5000 acres, sometimes.

In addition to gravity irrigation, lift irrigation is also done on a fairly large scale, involving large areas, especially in Hvai and lower Yangtze basins. The area of the "Irling Lift Irrigation Project" about 60 kilometres from Nanking is 10,000 hectares (22,000 acres), the main crops being rice.

Water and Soil Conservation

One of the main contributing factors for a more successful flood control work is an efficient method of conserving water and soil, because floods occuring in a river, on account of the excess water, can still be aggravated by the heavy silt that is carried by the inflowing water from the catchment area, as is the striking example of Yellow river in China.

In fact, the main cause of frequent floods in the Yellow river is and has been due to the heavy silt carried by its waters. The reason for this is that the whole of the drainage area of the middle reach of this river consists of loess plateau, which gets severely eroded by rain storms during each rainy season. The extent of this area is about 220,000 KM^2 out of its total drainage area of 745,000 KM^2 i.e. nearly a third. In the upper reach of Hai river basin also, soil erosion is very serious. Due to the heavy deposition of silt in its lower reach, Yellow river has become an elevated river.

Another attendant bad effect of the soil erosion is the gradual impoverishment of the farming lands, due to the top soil getting washed away, each year.

Hence, as one of the major measures for effective flood control, water and soil conservation work is being done on an extensive scale, especially in the middle reaches of Yellow river and the upper reaches of Hai river.

The main methods for water and soil conservation that are being done consist mainly of agricultural methods. These may be:—

(1) Deep ploughing
(2) Hoeing between the rows immediately after the rain

(3) Planting crops in furrows, following the contours and preparing such furrows on fallow land
(4) Close planting
(5) Laying out "Buffer grass belts" between furrows
(6) Growing green manure in fallow periods
(7) Proper crop-rotation
(8) Controlling grazing on pasture
(9) Terracing fields on sloping lands
(10) Banking cultivated slopes
(11) Laying out systems of ditches to collect and drain out water
(12) Ditching and banking along contour lines
(13) Stopping cultivation of steep slopes and planting them with trees and grass etc. etc. Large scale afforestation is also one of the good methods, such as, planting of trees on the bottom and slopes of gullies, on river banks, on the banks of reservoirs and on alkaline land, and also planting of wind breaks to fix shifting sand and to protect farmland. These methods have got the double advantage of conserving water and soil and also increasing the culturable area and agricultural production.

In hilly and mountainous areas, hydraulic methods are favourably adopted, as

(1) Banking heads or sides of gullies to prevent them from extending upwards.

(2) Building gully check dams, soil saving dams (to hold back silt and make it available for recovering as arable land and big earth dams.

(3) Improvement of soil through recovery of silt (by conducting silt laden water on to dyked plots and draining it off after its silt has settled).

(4) Building small irrigation works

(5) Building storage ponds to hold back water and silt and sumps to retain rainwater, etc., etc.

The noteworthy aspect about the work of "water and soil conservation" is the way in which they are being done through the active co-opperation of peasants themselves in the respective areas, because, as this work generally covers very large areas, getting adequate labour at each place to do this work is extremely difficult. Usually the works (say, hydraulic measures in particular) to be done, are in out of the places and by securing the co-operation of the local peasants, it has been possible to do this tedious work quite easily, without the necessity of having to transport labour from one place to another which is a very difficult job.

To be able to adopt the most suitable methods to suit the local conditions of each area, "water and soil conservation experimental stations" are also established in the areas subject to serious soil erosion, such as in the middle reaches of Yellow river, there are 3 experimental stations, each covering a portion of the whole soil erosion area. Here experiments are done on

Agricultural methods
Afforestation methods and also on
Hydraulic methods

As a result of experiments, they have found out that a particular kind of grass similar to alpha-alpha, provides a good vegetation cover to protect the soil. This variety (called as Chao-Mushi) grows to a height of 3 to 4 feet and can serve as fodder in early stages and as fuel in later stages. In the afforestation part of the experiments, it has been found that a variety of tree called "sweet clover (Latin naeme) grows quickly and favourably in eroded areas, and is much useful in fixing "shifting sands".

Based on the successful experimental results of these research stations, respective methods are being adopted to suit each particular area.

Small-scale Water-Conservancy Works

It has been recognised that, small scale water-conservancy works produce quick results in the increase of agricultural production by the quicker irrigation facilities afforded by these types of works. These can not only be finished quickly but economically also, when compared with the long time and the huge amount of expenditure involved in the big projects. So nowadays considerable attention is being paid to the execution of these works almost all over the country.

Works under this category include small earthen bunds, canal excavations, small sluices and headworks, digging of wells and ponds and small scale lift irrigation by waterwheels and pumps and lastly in certain cases, they also include small-scale rural electrification projects, making use of the "canal drops" of the irrigation canals.

The success of these works, as already said in the case of water and soil conservation measures, is in getting these works done fairly quickly and economically, by the locally available labour of the respective areas, mostly consisting of peasant labour.

Generally, the vast mass of agricultural peasantry have little work to do in the "slack season". During this period, by enlisting their co-operation, small-scale waterconservancy works can be easily got done as the mainpart of these works is simply earth work.

Speed of Construction

In the execution of her water-conservancy works China has achieved and is achieving appreciable speeds. The important factor contributing to the speed of execution is the way in which labour is secured, managed and the work got done by them, for, till recently most of the water conservancy works that have been done, say during the last 8 years, are mainly by manual labour. The very recent Sanmen-gorge dam project on the Yellow river which is going on since April 1957 is fully mechanized, starting from the quarry up to the dam.

Especially in the case of earth work, say of canals

and other works, considerable speed has attained, mainly by the creation of entbusiasm and proper organisation of peasant labour, e. g., it is mainly by enlisting the co-operation of the local peasant labour, specially during the flood season, China is able to build, maintain and protect her entire "flood control dykes" along almost all her big river systems.

In the execution of Dam projects and barrage works also, speed attained is interesting to note, such as:

The Chinkiang flood detention basin project which consistsed of 8 million cubic metres of earth work, .12 million cubic metres of concrete and erection of 54 radial gates of size 18M×4M each, was completed in 75 days time during 1952, enlisting also the assistance of the army during the construction work.

The Futzeling multiple arch dam which involved pouring of .2 million cubic metres of concrete and inserting 4000 tons of steel, was completed in little less than 2 years' time, as also the multiple arch dam at Meishan, which, incidentally, is the highest of its kind in the world.

The Shavlungdiyan concrete arch dam, 84M in height and the Mozetan hollow buttress dam 82 M in height which were started during September 1956, were nearly 80% finished at the time of my visit in November 1957 and are proposed to be completed by June 1958. The amounts of concrete in the Shavhungdiyan and the Mozetan dams are 28 million cubic metres, and .3 million cubic metres respectively.

Generally all the important and big project works are done almost non-stop throughout the year and also in 3 shifts, starting from the foundations up to the finish.

These points will be of special interest for us, as the conditions in China and India are similar i.e. plenty of available man power and shortage of construction equipment, so that, by the proper use of the existing manpower itself, big project works could be finished at a quicker rate, so as to get benefits earlier, in the form of increased agricultural production and power etc., which are the vital needs for our economy.

China's Experience

Long before my going to China, I had known that China has got a good experience in flood control works and has done a lot. My visit to those places confirmed this. As already said, Yellow river valley is noted for its flood control works since very long, e.g. history records that even as far back as 3000 years ago, the King called Yui tried to control the Yellow river floods by excavating a system of diversion canals. In the maintenance of the dyke systems and especially for the emergent works during flood season, simple but effective methods are used, such as, facin work, willow tree branch and stone work, combined in the form of bundles and stone dumping etc. to prevent any scouring of dykes and the interesting "Probing method" to detect any hidden holes and hollows in the dykes. Nowadays many flood detention basins and flood retarding areas along the rivers, have been built to combat the floods more effectively. These simple methods and the way in which they are got done are quite interesting and noteworthy.

In the field of irrigation also, work is being done on a scientific basis by establishing irrigation experimental research stations in all big irrigation areas and using their data. At the Dam project sites, Chinese engineers were feeling confident that they could finish project works even quicker for example, at the Mozetan dam an engineer told me that they can, in future, build dams similar to Mozetan dam in about 12 to 15 months.

In spite of all these, at the present stage, China feels the necessity of foreign help in the design and execution of her big water-conservancy projects and I learnt that most of the methods that are being followed in the planning, design and execution of her water-conservancy projects—irrigation as well as Dam projects—are all based on the advanced techniques and experiences of Soviet Russia. The technical literature and books which are largely being used at present in China are all Soviet books, covering every technical field, which, I learnt are quite precise, uptodate and are more practical. For instance, based on their advanced methods, China has built different types of concrete dams, such as, arch dams, multiple arch dams and hollow gravity dams.

Interest in India

Wherever I went and talked with the Chinese engineers, I found them quite interested and anxious to know about the water-conservancy projects being done in India.

Many of the engineers know about and are very much interested in our Bhakra Dam project, especially on knowing that it is the highest dam being built in Asia. Many engineers told me that India's irrigation is quite advanced and fairly old, especially referring to the irrigation works of Punjab and the Upper Ganges Valley. But regarding our other big projects that are going on, they had little knowledge or sometimes did not know about, which shows that mutual contact, in the field of water-conservancy work has not been much.

This sort of mutual appreciation I believe could still be increased to the benefits of both the countries by increased mutual visits of enginners and exchange of technical literature on a large scale.

Conclusion

During recent years, in the field of water-conservaancy works, China has been able to do quite a lot. A notable feature about the water conservancy projects is her efforts to do them quickly and also economically at the same time. With this idea in view, nowadays, many hydraulic laboratories and research stations have been established and also at every project site

there is a small laboratory, to have a check on the quality of work; may be at an earth dam site or a concrete dam site or in a big irrigation area. In attaining good speeds in construction, much is being done by the co-ordinated hard work of both techincal and non-technical personnel, i. e. Engineers and the Labour.

For quicker execution of the water conservancy works, co-ordinated and comprehensive planning for the river basin as a whole is done, so that "water and land plan" is first made, for a basin, and then, as per the necessity and priority, each individual project is taken up for further detailed designs and execution.

As a result of this, there are the different River Commissions and design officers responsible for the developing and exploiting of the water resources of different river basins, such as:

The Yellow River Commission and design office, responsible for the development of Yellow river basin, the Hvai River Commission and design office responsible for the development of Hvai river basin, The Yangtze River Commission and design office, responsible for the development of the Yangtze river basin and the Central design office at Peking at present is working over the Hai river basin "water and land plan". Each of these Commissions, has got a research laboratory of its own, in addition to the Central "Hydraulic and Scientific research laboratory" at Peking.

Because of these separate Commissions, it has been possible to do concentrated work in each basin at a good speed. If, in some cases, there is not enough hydrological data pertaining to a river basin, the Commission can survey and collect accurate hydrological data, by establishing a series of Hydrological and Rain gauge stations at key points, so that the scientific data can be used at any time, if not in the immediate future.

Our river systems, in India, also could be developed on this "Basin Planning" method, especially, say, the Bramhaputra and the Ganges river systems by means of Independent Commissions for each, so that, by doing concentrated work, much could be done to quickly overcome the flood menace in these two areas, which are threatened by floods, almost every year, and also try to exploit their water resources collectively.

This, I feel, is also the method, followed in the United States, as is the case of the famous T. V. A. and the very recently proposed "California Water Plan" which envisages the construction of about 376 reservoirs with a gross storage capacity of about 77 million-acre feet.

In the preparation of her "water and land plans" and also in the execution of her big projects, China has drawn considerably from the experiences of Soviet Russia, in the field of water-conservancy, so that, I feel, India too, could benefit much, by establishing contacts with the Soviet Union, in the field of water-conservancy, in the form of sending students and engineering delegations, etc.

Altogether, it was an unforgettable year, which I spent in China. Still fresh in my mind are the various types of Buddha's images, in many of the Chinese temples, which shows that the contacts between India and China, are nearly 1300 years old.

Nowadays, thanks to the modern communication system, we can travel between our two countries, quicker and often. I, as an engineer, hope that the members of my profession, Hydraulic Engineering, will visit each other's country frequently, so as to gain from each other's experience and help one another in the building up of our two friendly countries.

OUT-BOARDS AT WORK

An extensive research project has disclosed interesting and diverse uses of the outboard motor from Arctic seas to tropical rain forests.

The outboard motor, because of its dependability, mobility, light weight, power, and economy of purchase and operation, has become a marine workhorse in hundreds of primitive as well as civilized areas throughout the world. This is clearly demonstrated in the new book "Outboards at Work", published by Outboard Marine International S. A., world-wide marketing agency for Evinrude, Johnson and Gale-Buccaneer outboard motors.

The book developed as the result of a broad field study of the practical uses of the outboard motor. Its sixty-four pages and 122 photographs depict the importance of this small power package in fishing, transportation, lumbering, public service, marine construction, mining and many other fields of activity.

The findings of the survey group were compiled in book form by William H. Taylor, Pulitzer Prize-winning writer and managing editor of "Yachting". The photographs portray the actual operation of outboards on many unusual craft employed in twenty-seven countries.

Copies of "Outboards at Work" are available, without charge, by writing the Public Relations Department, Outboard Marine International S. A., Nassau, Bahamas, or Oristano Associates, 551 Fifth Avenue, New York 17, New York.

Technical Notes & News

NEW ADVANCE IN LOADING TECHNIQUE

Developments in the technique of loading broken rock, loose earth etc., have been rapid during recent years. It is only a few years since the bucket-equipped crawler tractor came into the market and quickly created a new type of loader. It gave contractors, industrial concerns, mines and opencast operations a readily mobile and relatively inexpensive, alround, high-capacity loader, since a crawler tractor with a loading bucket of 1-1½ cu. metres capacity is in many applications the ideal loader for heavy materials.

This line has now been developed still further by a Swedish invention which substantially boots loader capacity and cuts loading costs generally but which *moreover* makes it possible to employ mechanical loading in spaces so confined that conventional loaders cannot be economically used for lack of elbow room.

Illustration showing loader in operation.

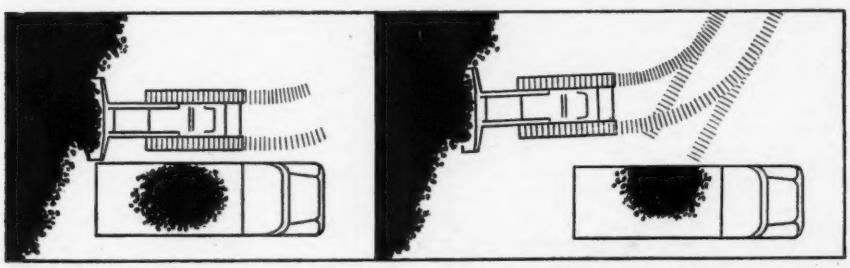
This improvement in loading economics has been brought about by the Libu *side-tipping* bucket and the Libu method which it has made possible. The Libu bucket was designed by a Swedish engineer on the staff of LKAB—the world's largest iron-ore mine, situated in Kiruna in Arctic Sweden. After some trials and design modifications with the prototypes—they have been used in tunnels and opencast cuts on the hardest conceivable loading—the Libu bucket has now been brought to its final form and is being marketed by the Swedish firm of *Libu Shovel Co. AB*

The Libu bucket differs from that of the conventional loader in that it can be tilted as desired *to the right or left* as well as *forwards*. A conventional bucket, of course, can only tip forwards.

The chief gain in tunnel loading with the Libu method is that it eliminates the need for rearward-dumping loaders, which are both costly per cubic metre loaded which require the use of special transport vehicles. In many cases it also supercedes another loading method which is but poorly adapted to the purpose—that of backing out of the tunnel or to a turn-round point specially made in the rock in order to bring a forward-tipping loader into its dumping position.

The advantages of using the Libu method on poen ground are twofold—firstly the higher capacity resulting from the shorter distance covered by the tractor, with the consequent shortening of the working cycle, and secondly the reduction in wear on crawler tracks, giving better tractor economy. Apart from a minor adjustment of its position in order to reach a point suitable for dumping onto the truck, the Libu-equipped loader moves forwards and backwards only.

Diagram showing the difference between Libu-loading and conventional loading.



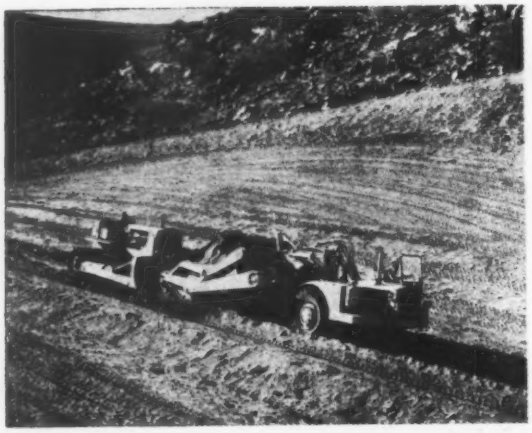
Side-tipping LIBU-shovel

Ordinary forwards-tipping shovel

TRACTOR-SCRAPER COMBINATION

Another major addition to its 1959 product line was announced by Caterpillar Tractor Co. recently, with the introduction of the No. 619 wheel Tractor—No. 442 Scraper combination. This new machine makes available a Caterpillar-built two-wheel rubber-tired haul unit in the same size class as the Company's DW15 wheel Tractor.

In addition, the No. 619 has been designed to operate safely and effectively at high speeds, formerly possible only with 4-wheel hauling units. The validity of this performance breakthrough was thoroughly proven in a 4-year development program, during which prototypes of the new earthmoving team were tested on job sites throughout the country.



Before market-availability of the new Caterpillar No. 619 Tractor-No. 442 Scraper, the earthmover was tested on a variety of jobs throghout the country.

The new No. 619 Tractor is powered by a 225 HP, turbocharged diesel engine, especially matched in power-output to the demands of the 44 cu. yd. (struck) capacity of the No. 442 Series B Scraper. The engine develops maximum rated horsepower at 2000 RPM, and incorporates a specially-designed turbocharger which aids in providing a high, 20% torque rise, tailored to provide the proper power characteristics needed in scraper operations. Additionally, the engine retains the Cat features of an adjustment-free fuel system, dry-type air cleaner, special alloy valves, aluminum alloy pistons, chrome-plated rings, and water-jacketed cylinder liners.

High Travel Speeds

Top speed of the new earthmover is 30.2 MpH a feature considerably lowering cycle-times and increasing production over similar-sized two-wheel tractor-scraper units. This high travel speed has been made possible as a result of research into tractor-scraper balance conducted by Caterpillar engineers as a prelude to designing the No. 619-No. 442 combination. Previously, the uncertain roadability and difficult steering characteristics of two-wheel haul units operating at high speeds had served to limit their use on applications where long hauls and fast travel speeds were required.

However, the design of the No. 619-No. 442 combination eliminates these shortcomings by dampening high-speed bouncing and vibration in the structural configuration of the machine itself. The smooth ride of the No. 619 is provided by a carefully-engineered relationship of centers of gravity, wheelbase, turning points, weight distribution and machine harmonics.

Easy Accessibility

Production is given a further boost by the unprecedented accessibility of tractor components designed into the No. 619, a feature which materially cuts service time. As examples: the transmission, differential, and cable control can be removed as a single unit by one man in approximately 30 minutes; the cable control alone is removable in 10 minutes. The clutch may be taken out by one man in approximately 30 minutes, and does not necessitate removal of the engine. The engine itself can be completely removed in approximately 3 man hours.

In pointing up the new machine's low operating cost the manufacturer pointed out the engine's ability to burn a wide range of non-premium fuels, a characteristic of Caterpillar-built diesel engines.

90° *Hydraulic Steering*

The new hydraulic steering system on No. 619 Tractor incorporates a built-in safety device, in that a greater amount of turning power is provided when coming out of a turn, than when going into a turn. This feature assures the operator enough available power to turn out of any adverse ground condition into which he may have turned.

Basically, the new hydraulic steering system is similar to that on the Company's DW21, in that full 90° turning is available.

Advanced Features

The importance of other significant features in the power train and related internal components of the new No. 619 Tractor was also detailed.

The flywheel clutch is a two-plate, dry-type, 16-inch clutch, whose unit design allows it to be removed easily through the use of a close-coupled universal joint between the clutch output shaft and the transmission. For ease of operation, the clutch is equipped with an air booster.

The No. 619 transmission is barrel-type, providing six forward and two reverse speeds. Its bearings and constant mesh gears are pressure lubricated, with completely filtered SAE 90 EP oil

The tractor's final drive component is a planetary gear arrangement. The quality design and parts in this critical area were especially cited by the manufacturer. Of special note is the split-type roller bearings used in the planet gears. These bearings, used exclusively in the Cat-built No. 619 planetary system, provide the precise area required for support, while preventing bearing distortion.

By removing six capscrews in the planetary drive case, each axle can be easily withdrawn from the tractor. The planetaries are interchangeable between sides, with full-floating axles connecting the differential and sun gears.

The brake and air system on the new unit is basically the same as used on Caterpillar's current line of wheeltype tractors.

Rugged Lowbowl Scraper

The No. 442 Series B Scraper, which serves as the No. 619's earthmoving partner, has a capacity of 18 cu. yd. (heaped). **LOWBOWL** design, a characteristic of Caterpillar's scraper line, provides quick, easy loading to full capacity.

The No. 442 Scraper is cable operated, with positive controlled "dozer" type ejection, apron opening of 5′ 4″, adjustable scraper axles (to level the bowl), and wide section, tubeless tyres. Air operated Syncro-Safe brakes are standard. An automatic bowl latch is available as an optional attachment.

ECONOMICALLY COMPETITIVE NUCLEAR POWER

A private industry proposal to make nuclear electric power economically competitive with conventionally produced power in the U. S. by 1965 through intensive development of the boiling water reactor was announced by the General Electric Co. Francis K. Mc Cune, General Electric vice president and general manager of the Company's Atomic Products Division, said that the plan is now being presented to the nation's utility industries and to the U. S. government.

At the same time, he announced that a small nuclear power plant had been designed, suitable for mass production and installation today on a wide scale across the country, in order to permit utilities to develop the necessary experience in producing atomic power by the time that economic, large-scale nuclear plants become available.

The over-all General Electric program, he explained, is divided into two parts. One part, called **OPERATION SUNRISE**, calls for the accelerated development of boiling water reactor power plants to make them competitive with conventional power plants. The other part, called **OPERATION KNOWHOW**, proposes the construction and operation of a number of small boiling water reactor power plants to accelerate operational experience in the nuclear power field.

Operation Sunrise would bring into operation by 1962 five' 'developmental" nuclear power plants which would provide answers to vital technological questions barring the way to competitive nuclear power.

Such developmental plants would be followed in 1965 by three "evolutionary" plants which would be economically competitive in higher fuel cost areas in this country. The evolutionary plant would produce power for about 8-1/2 mills per kilowatt hour.

By 1970, Mr. McCune said, we would have large "target" plants producing power for 6-1/2 mills per kilowatt hour which would be competitive with 25% of the fossil fuel power plants being installed at that time in the United States.

Cost of Operation Sunrise would be $128 million over a period of seven years, excluding cost of plants which would be economically competitive. The program would be financed largely by industry, but would dovetail with the present program of combined government and industry development.

Operation Knowhow proposes the mass production of a large number of small boiling water nuclear power plants for purchase and operation by utility companies throughout the country in order to gain accelerated field experience. General Electric is prepared to build up to 25 of these plants, while it is expected that other manufacturers in the atomic industry would be able to provide at least this same number of plants.

Each plant, powered by a boiling water reactor, would produce 5,000 kilowatts of electric power.

Construction and operation of these power stations would be for purposes of gaining operational experience with nuclear power in the field prior to the operation of large-scale economic nuclear power plants.

Mr. McCune said that the program proposed by General Electric is designed to "complement over-all industry and government efforts to assure world leadership by the United States in one of the most important technological areas of the future." He said that atomic acceleration is now "an accepted and irrevocable fact" in this country and that, in recognition of this, the General Electric Company had developed this program as a means of achieving economic nuclear power "in the shortest possible time and at the lowest possible cost."

Mr. McCune said that the decision to concentrate on the boiling water reactor concept came as a result of 12 years of General Electric experience in design,

construction and operation of atomic reactors and after a thorough analysis of other types of reactors proposed both here and abroad.

In Operation Sunrise, he said, the utilities would have in operation by 1962 a group of five developmental plants which would provide knowledge required to produce competitive atomic power.

First step in Operation Sunrise already has been accomplished. It is the development and construction of first-generation boiling water nuclear power plants as technological base. Mr. McCune said that these plants include the Vallecitos Boiling Water Reactor operated by General Electric and the Pacific Gas and Electric Company, near Pleasanton, California, and the Experimental Boiling Water Reactor developed by the Argonne National Laboratory at Lemont, Illinois, both now in operation.

This step also includes a large-scale Dresden Nuclear Power Station being built by General Electric for the Commonwealth Edison Company and the Nuclear Power Group. The Dresden station will be in operation near Chicago by 1960.

Second step in the development program and the most important, he continued, is construction by 1962 of three small boiling water reactors and two of medium size, each for the purpose of solving a different but vital technological problem. One of these plants already has been committed.

Boiling water reactors were chosen for the program, he explained, because extensive development work already carried out indicates they have the best chance for producing competitive nuclear power, and because it is now possible to chart specifically the remaining steps for future development.

The General Electric vice president gave these additional reasons for choice of the boiling water reactor: (1) Boiling water safety characteristics have been proved. (2) Operation of these reactors has proved their inherent simplicity and high efficiency. (3) Capital costs of boiling water reactors are the lowest of any proven reactors.

Mr. McCune stressed that the proposed program was not intended to supplant development programs for other types of reactors now being pursued by industry and government or others under consideration. General Electric is actively continuing work on other reactors, but has selected the boiling water type as today's most promising candidate for "development in depth" to reach competitive economic status in the shortest possible time, Mr. McCune explained.

"Developmental" plants to be built in the second step of Operation Sunrise were listed by Mr. McCune as—

1. The 50,000-kilowatt plant GE's Atomic Power Equipment Department is designing for the Humboldt Bay Power Plant, which the Pacific Gas and Electric Company is building near Eureka, Calif. with Bechtel as prime contractor. This plant will exploit the cost reduction potential of system simplification.

2. A 25,000-kilowatt compact plant to study cost cuts through reduction in physical size.

3. Another 25,000-kilowatt, high-power-density plant to prove out the possibilities of reducing capital cost by doubling power output per unit reactor core volume.

4. A 100,000-kilowatt or larger high-power-density plant to test power density limits obtainable in a medium size reactor and to provide a full-scale test of high power density fuel.

5. A 50,000-kilowatt separate nuclear superheater used as a "hook-on" reactor to an existing boiling water plant to demonstrate characteristics of a superheating reactor in conjunction with boiling water reactors.

Third step in the program would be operation by 1965 of three large-scale "evolutionary" plants to incorporate advances made in the developmental plant series. These three plants, which might include a 100,000-kilowatt natural-circulation plant, a forced-circulation 200,000, kilowatt plant and a 325,000-kilowatt superheater plant, would be competitive for the electric utilities that operate them.

Fourth step would be operation by 1970 of three "target" plants, possibly in the 450,000-kilowatt range, with capital costs of from $175 to $225 a kilowatt. These plants would be an extension of the "evolutionary" plants series. Fuel costs would be from 1.7 to 2.2 mills per kilowatt hour. These plants are expected to be competitive with at least 25% of the U. S. fossil fuel plants then being installed.

Fifth step would be attainment of widespread competitive nuclear power plants resulting from further improvements in plants that would come in the normal competition of industry. At this stage, McCune said, electric utilities in most areas of the country would have turned to nuclear power, generated at costs well below those of fossil-fuelled plants.

Key to the Operation Knowhow program, McCune said is development of nuclear field experience and furthering of public acceptance while technical problems are being worked out.

The small plant design announced by General Electric, for Operation Knowhow, is based on experience gained with the Vallecitos Boiling Water Reactor. Included in the plant package would be the reactor and a sphere enclosure, initial fuel load, the turbine generator power plant equipment, auxiliaries, a control room and service building. Delivery of the first plants would start in 1960.

Construction of up to 50 of these small atomic power

plants across the nation, the General Electric vice president said, "would provide this country with the finest field experience network in the world, as well as a valuable facility for carrying out advanced tests of fuels and components." During construction of each plant, he said, selected operating personnel from the utility installing the plant would be sent to General Electric and other nuclear installations for training in nuclear technology.

He recommended that plants be built within easy driving distance of population centers so that the public can become acquainted with progress in developing nuclear energy. Work could go ahead in advancing of health ordinances, safety regulations, licensing procedures and other measures relating to peacetime atomic energy. He said that goals of the Operation knowhow would include:

1. Well trained, competent nuclear power plant technicians in place and with operating experience at the time that large-scale economic plants become available.

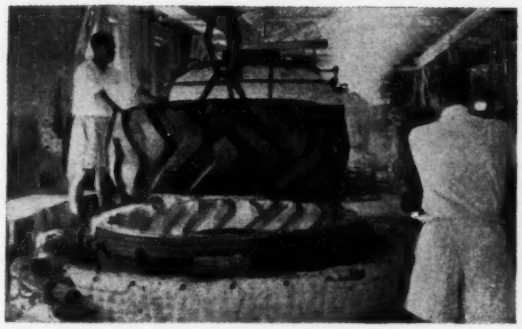
2. Accelerated experience with reactor components, hardware and fuel.

3. Increased public and community understanding of the uses of atomic power, to get it out of the "mystery" realm.

4. Orderly formulation of realistic health ordinances and local and state safety regulations.

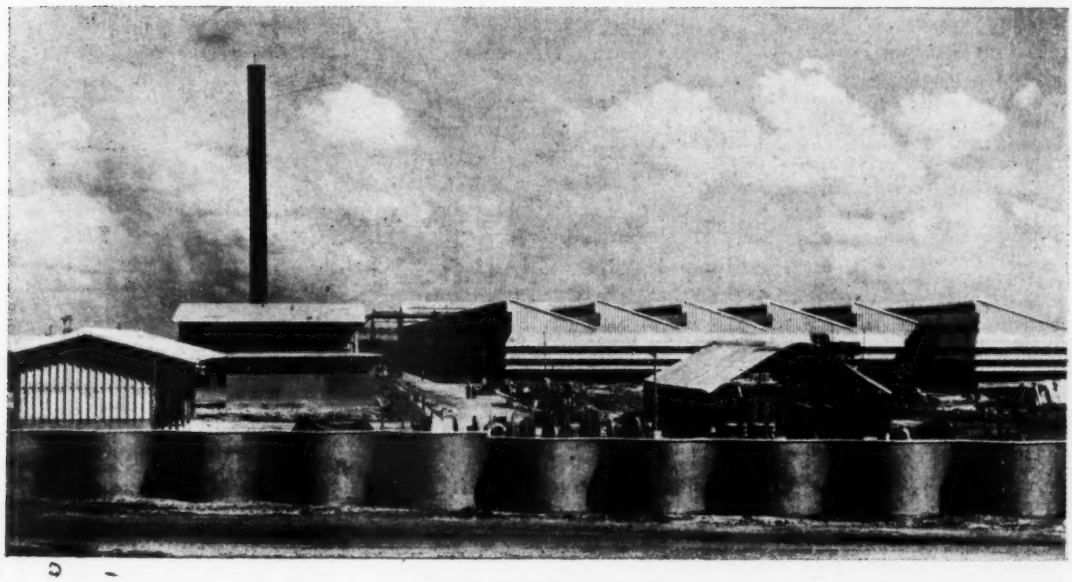
5. Development of AEC licensing procedures on a wide scale.

6. Established and working insurance relationships.



A recent addition at the Dunlop Factory at Sahaganj is the plant for the manufacture of large earth-mover tyres required in river valley projects.

An exterior view of the Dunlop Factory at Ambattur, under construction.



NEW CABLE PROJECT

Speed has been the keynote of a new factory at Bauria (near Calcutta) being installed by Fort Gloster Industries Ltd (Managing Agents Kettlewell Bullen & Co. Ltd) to manufacture various kinds of electrical wires and cables. The Company has entered into an agreement with the B. I. C. C. of London for technical collaboration in this Project and what is called the C.V. (continuous vulcanisation) process, a fast and most modern method of producing high grade rubber insulated cables and wires, is proposed to be adopted, for the first time in India, by this factory. Some sections have already started working and the entire factory is expected to go into full production very shortly. This addition to the country's production of wires and cables is expected to meet the domestic requirements to a large extent.

SOIL-LESS PLANT CULTIVATION IN THE SAHARA

Experiments in cultivating plants without soil are being carried out at Beni-Abbes under the direction of the French National Scientific Research Center and are intended to solve two problems at the same time:

1. Raise plants in ground which does not contain any humus or other organic matter;
2. Develop new methods of cultivation which will require a minimum of water.

Up to now, these experiments of the Center have given very satisfactory results.

At the Beni-Abbes station, concrete boxes filled with sand contain magnificent heads of salad and cabbage, cress, radishes and other vegetables.

The process developed by the technicians of the Center utilizes concrete boxes, 12 to 15 feet long and 3 feet wide, which are filled with a layer of non-calcareous gravel fines and provided with the nutritive elements necessary for the development of the plants. The quantity of water used in these experiments is very small and may drop as low as three liters per square meter (3/4 US gallon per 10 square feet) per day during the winter.

It is now believed that the experimental stage will be completed at the end of this year and that it will be possible to start soil-less cultivation on a large scale at that time. If this is successful, it will be an invaluable aid in supplying fresh food to the petroleum fields of the Sahara.

SIGNIFICANT DATA ON CALENDAR YEAR 1958 OPERATIONS DISTRIBUTORS OF POWER AT TVA RATES

	Calendar year 1958	*Change* '57 *to* '58	*Change* '46 *to* '58
Residential			
Total kWh sales	9,232,747,000	+19%	+773%
Average rate per kWh	1.04c	−5%	−38%
Average kWh per Consumer	7.765	+15%	+269%
Average bill per Consumer	$80.63	+9%	+127%
Commercial & Industrial—(*Demand under 50 kW*)			
Total kWh sales	1,962,817,000	+8%	+246%
Average rate per kWh	1.39c	−2%	−19%
Average kWh per Consumer	13,555	+6%	+111%
Average bill per Consumer	$188.42	+4%	+70%
Commercial & Industrial—(*Demand 50 kW & Over*)			
Total kWh sales	4,619,188.000	−3%	+233%
Average rate per kWh	0.71c	+4%	−3%
Total			
Total kWh sales	15,945,353,000	+10%	+425%
Average rate per kWh	0.99c	−2%	−22%
Total No. Consumers	1,363,311	+3%	+119%

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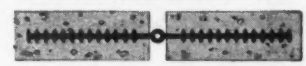

KEEPS DURAJOINT WATERTIGHT

This is what happens when Durajoint is subjected to lateral stress. The Durajoint remains watertight because the stretch is confined to the central tubular section of the material. THE RIBBED SECTION HOLDS FAST TO THE CONCRETE—even under extreme conditions.

Editorial

Cultural Change and Technical Education

Professor M. G. Salvadori, of the University of Columbia, has written an extremely thought-provoking paper in the Journal of Professional Practice, Proceedings of the American Society of Civil Engineers (vol. 85 No. PP 1, May'59) entitled "Humanity faces a technological culture". He points out that "humanity was never faced with such speed changes in the cultural aspects of practically all her societies and that the tremendous ecucational difficulties all over the civilised world today are symptoms of these changes". He argues that "any discussion on education which does not carefully consider the new tempo of history and is artificially limited to the consideration of specific educational problems is useless and wasted".

Our country is going through an industrial revolution which was delayed for historical reasons by several centuries. We are thus trying to catch up with the industrialised world but, as we have already experienced, the lack of general education amongst our people and the absence of technical knowledge even among the educated few is heavily coming in the way of our rapid progress. Thus we are doubly faced with the urgent task of promoting modern technological and scientific education among our younger generation —an education which our present day educators have become backdated to tackle. This makes Prof. Salvadori's comments all the more relevant in the Indian context. We have not only to promote the general increase in the standard of education of our people but we have also to keep in view "the new tempo of history" that surrounds us with all its brilliance.

Prof. Salvadori has given extremely interesting examples from the wide range of human experience to indicate the new tempo. For example he points out that the population of the world has increased since the French Revolution from one billion people to over 2½ billion. The experts tell us that in another 100 years we might be over 6 billion. Thus the fact that the earth is getting crowded is new. Further, the "psychological density" of the world has increased much more rapidly than its numerical density.

There is still another interesting aspect of the same situation. This increased population finds itself on a "greatly shrunken earth". We can travel from New York to Paris in 10 hours but our thoughts can travel the same distance in a matter of a few seconds. Through television the distance between the "observer" and the site of the event has been considerably diminished, so that millions more can now "see" the event taking place hundreds of miles away. Our intercourse with the other people of the world is ten thousand times more intimate than before. The influence of technology such as that provided by the radio, the T. V., the planes, the sulpha drugs, the penicillin, the atomic bombs, the nuclear energy, rockets etc. compared to that even of 50 years is simply overwhelming. Our psychological cultural conflicts are on the increase. Nuclear energy has changed the pattern of world power by eliminating the hegemony of those who have sources of oil, and hydrogen bombs have made war impossible, requiring serious consideration of new means of settling political problems. Rockets are opening up space to us who only yesterday were madly fighting over national boundaries.

All of these is physically, and mentally and morally new.

Even in the field of arts never has been the participation of the mass of people as lively as it is today. Prof. Salvadori then goes on to explain how music, poetry, painting and movies are all giving us entirely new realms of composite arts.

But the most important and to us more relevant argument presented by the learned Professor is in the field of scientific thought. He says that modern technology is like a chain reaction and is fast developing new specialised fields than ever before. Thus the knowledge we impart to the present generation is becoming inadequate within a very few years and the whole effort appears to be wasted.

"One of the most dramatic consequences of this accelerated rate of change is the transformation of the usual under tow between the old and the new generations into what seems to be open warfare. The traditional respect for the opinions of the parent and the teacher has become a continuous challenge." "The separation of the generations brings about a new type of loneliness and sadness."

It is in this context of rapid change that an educational philosophy and a corresponding educational system needs to be developed that will suit the needs of the dynamic situation.

The minimum tools that the man of today needs are moral and intellectual. Morality could be expressed in terms of the "infinite respect for life in all of its aspects". "Morality can and must be taught by all those who surround the child, the young man and the adult". "Nothing less than worldwide morality will work".

In regard to the development of the intellectual tool, "it would seem that in the present circumstances one of the former goals of education must be abandoned:

we cannot hope to give our young men information, even incomplete information in any of the recognized fields of knowledge. The speed with which the essential new facts accumulate and change in importance from decade to decade indicates that the acquisition of factual information is by now the task of the mature, self-improving professional and not the aim of the student. The tendency to atomize knowledge through the institution of innumerable specific and specialized courses to be abandoned on two accounts: it is stultyfying, in as much as the information imparted in such courses may well be either false or totally immaterial a few years from now; it is dangerous, inasmuch as it tends to create specialists unable to grasp fundamental ideas and to communicate with others.

It becomes necessary, therefore, to consider education, even at the purely intellectual level, as a *formative* rather than an *informative* process. Education is to be considered as a training of the mind capable of transforming it into a sensitive and logical tool well adapted to mastering a variety of unforeseeable situations.

Prof. Salvadori then proceeds to suggest concretely the place of the study of language, mathematics and humanities that should be accorded to a modern man even of the realm of science and technology. We strongly recommend our educationists, scientists and planners to go through this very bold and yet specific approach to a persisting world wide problem.

Our Contributors

Mr. P. R. Guha, B. C. E. M.I.E., was born in 1905. Passed the Bachelor of Civil Engineering Examination from the Bihar College of Engineering in the last batch of 1928. Joined the Govt. of Bihar and Orissa as an Assistant Engineer (1929). Posted to Orissa in charge of Canal Embankment Sub-division (1929-30). Returned to Bihar in 1933 and posted to the charge of reconstruction of buildings in North Bihar after the earth-quake of 1934. Given Divisional charge in 1942. Posted to the charge of Post War Reconstruction Planning of Communication in Bihar (1944-45). Deputed to the Central Water and Power Commission for investigation of Kosi high dam and irrigation projects (1940-50). Became Superintending Engineer, Gandak Circle incharge of Gandak Project investigations and other works (1950-54). Appointed Technical Adviser in Kosi Project and thereafter as Additional Chief Engineer, Kosi Project (1954-57). Selected as a delegate for Bihar for attending the World Power Conference at Paris in 1955. Visited several river valley projects in France and Switzerland and gained experience of modern technique of treating dam foundations and constructions. Took charge as Chief Engineer, Irrigation (North), Bihar from January 1958, in addition to the charge of Chief Engineer, Gandak Project.

Mr. Leo Walter, is a Consulting Engineer and Technical Author of long standing.

Dr. Charles Jaeger was born in 1901 in Zurich, Switzerland, and received Secondary Education in Switzerland and Buenos Aires (Argentine). Obtained Diploma in Civil Engineering, Zurich Institute of Technology, 1924 and Doctor Thesis (Zurich) (1933). Professeur agrege (Zurich) (1943). Since 1946 special Lecturer on Engineering Fluid Mechanics and Hydro-Power Structures at the Imperial College, London University. From 1929-1946, Scientific Adviser to the Hydraulic Research Laboratory, Zurich (Prof. Mayer Peter). Since 1946, Consulting Engineer to the English Electric Company.

Dr. Jaeger has published well over 100 books and papers on Hydraulics, Fluid Mechanics, and Hydro-Power Structures.

1933: Theorie Generale de Coup de Belier.
1946/57: Engineering Fluid Mechanics.
1959: Contribution of 4 chapters to Guthrie Brown's "Hydro-Electric Engineering Practice".

Numerous papers on the Theory of Energy and Momentum of Flow in Open Channels, Surge Tank Design, Surge Tank Stability, Water Hammer, Arch Dams, Underground Power Stations, Power House Design, Economics of Hydraulic Designs and of Pumped Storage, Electric System Load Factor Analysis. etc.

Member of the Sub-Committee on Underground Works (Congress on Large Dams), Associate Member of the American Committee on Water Hammer (1933).

Mr. M. H. L. Whitehouse, M. A., B. Sc., A. M. I. Mech. E., A. M. I. E. E., is head of the Technical Division, British Engineers' Association.

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Printed and published by P. K. Menon from Inland Printing Works 60/3 Dharamtala Street, Calcutta 13
Editorial & Managerial Office : 6/2 Madan Street, Calcutta 13

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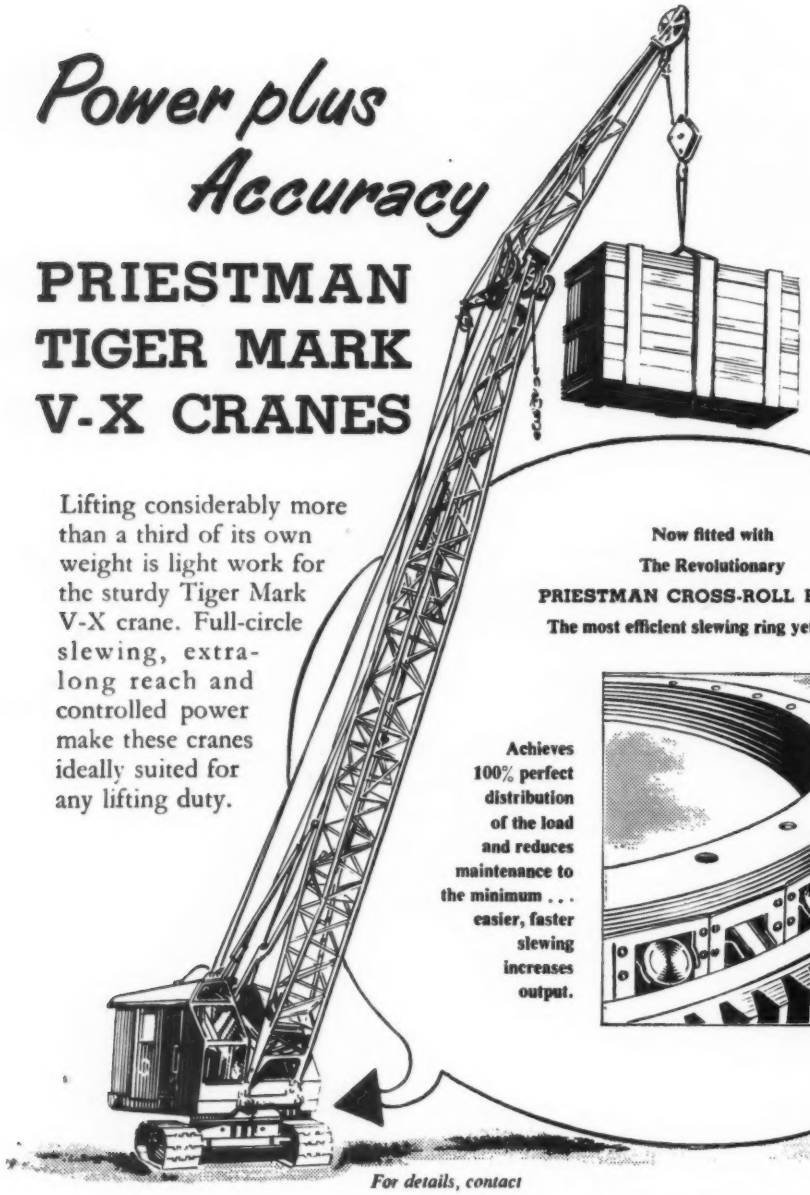

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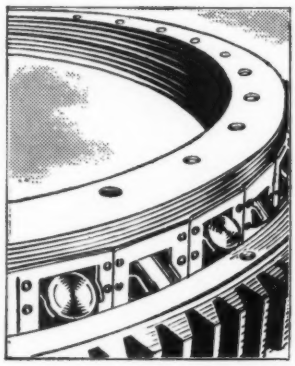

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